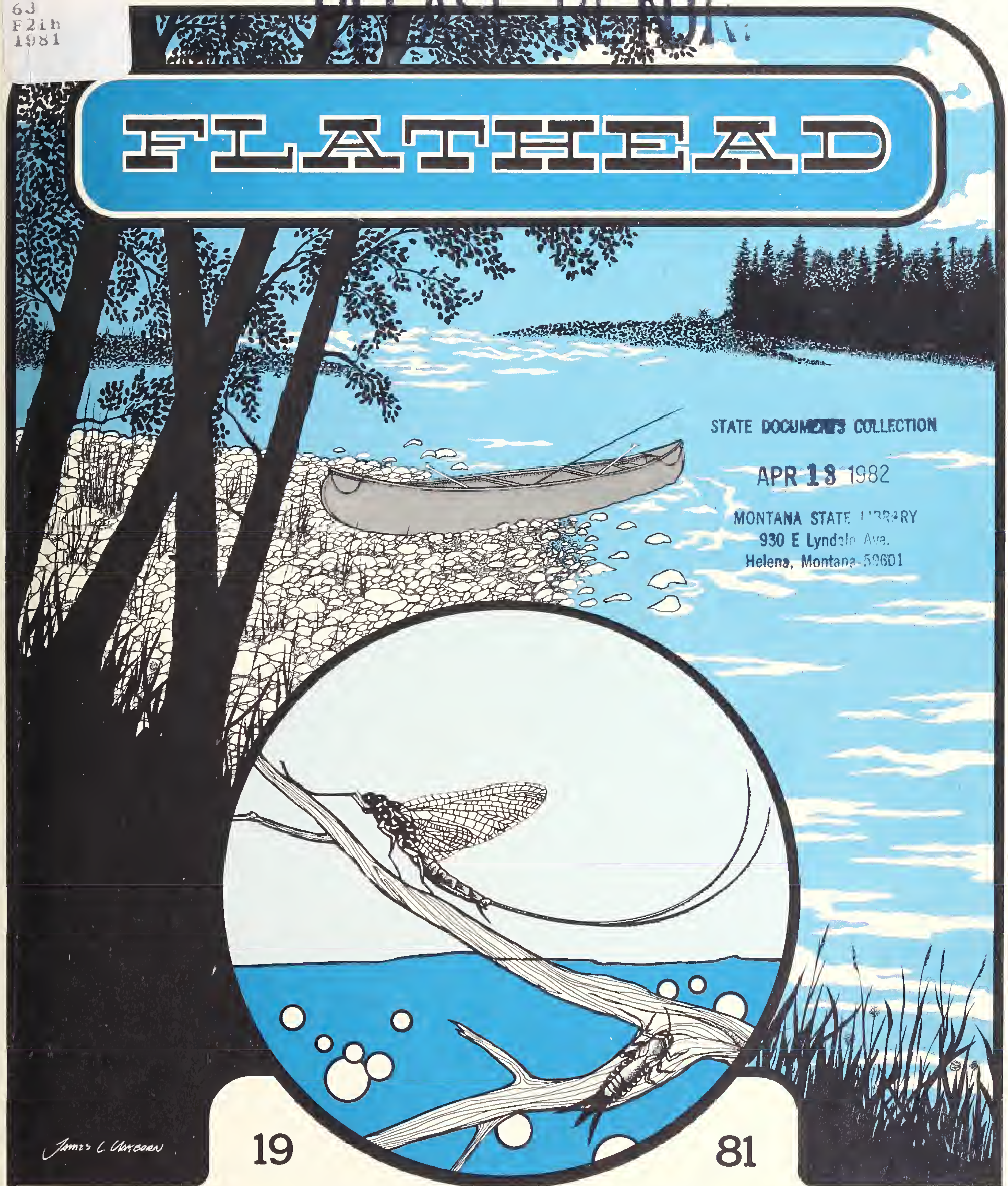

THE IMPACT OF HUNGRY HORSE DAM ON THE AQUATIC INVERTEBRATES OF THE FLATHEAD RIVER

Research Conducted By: MONTANA DEPARTMENT OF FISH, WILDLIFE & PARKS
Sponsored By: BUREAU OF RECLAMATION

THE IMPACT OF HUNGRY HORSE DAM ON THE AQUATIC INVERTEBRATES OF THE FLATHEAD RIVER

by

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EXECUTIVE SUMMARY

The aquatic invertebrate study was begun in June, 1979, as part of a fisheries study which was funded by the Bureau of Reclamation to assess the probable impacts of several proposed power alternatives on the aquatic biota in the areas of the Flathead River affected by discharges from Hungry Horse Dam. This report contains preliminary results of research completed since the last Annual Report (Graham et al. 1980).

The benthic invertebrate study was undertaken to provide baseline information on density and biomass, community composition, species diversity and life history characteristics of macroinvertebrates in the South Fork of the Flathead River downstream from Hungry Horse Dam and in the main stem Flathead River above and below the confluence with the South Fork. The 1981 Annual Report presents data on the following: a continuation of the tabulation of monthly mean density data for each species collected in the benthic samples which were taken at monthly intervals at three sample sites over a two year period; a comparison of invertebrate densities and biomass in control and regulated areas of the Flathead River which were calculated from samples collected during the 1980 water year (October, 1979 to September, 1980); an assessment of differences in community composition in control and regulated areas based on species presence and abundance at the three sites and on data obtained using Shannon diversity indices. The Final Report will include data obtained in other portions of the study; the evaluation of differences in community composition in regulated and free-flowing sections of the river using ordination techniques; the results of the seasonal study of the food habits of whitefish and trout in regulated and control areas; an assessment of the experimental study on the effects of different rates of increase in discharge and times of shutdown at Hungry Horse Dam on insect drift; and an evaluation of the effects of different discharge regimes on selected insect life histories. Management implications derived from another study (Perry, in progress) on the effects of river discharges on seston, periphyton, and Aufwuchs productivity will also be included in the Final Report.

Biotic diversity is severely reduced and community composition is grossly altered in the regulated South Fork of the Flathead River. The mean of the Shannon diversity indices for the four months which were used to calculate seasonal values was 0.8 at the South Fork station and generally in the range of 3.1 to 3.3 at the main river sites. The fauna in the South Fork was dominated by the dipteran family Chironomidae, which represented 85 percent of invertebrates by mean annual density. The mayflies, stoneflies, and caddisflies represented only four percent of the invertebrate density in the South Fork as compared to 75 percent at the control site. The combined effects of flow fluctuations, the severe changes in the temperature regime (varying from only 3° to 7° C annually and thus providing much colder summer temperatures and warmer winter temperatures), and the consequent changes in the food base for invertebrates are responsible for the marked changes in zoobenthic composition.

In contrast to the South Fork, both main river sites (above and below the confluence with the South Fork) had diverse insect faunas. No significant differences in overall diversity were shown between the control and partially regulated (downstream from the confluence with the South Fork) sites using Shannon diversity indices. The increase in biotic diversity which generally occurs with increasing distance downstream from a dam, occurs abruptly in the Flathead River where the South Fork joins the unregulated North and Middle Forks. The main stem Flathead River is affected by the addition of waters from the regulated South Fork, but the adverse effects on the macroinvertebrates are greatly tempered due to dilution by the North and Middle Forks. This can be attributed to factors such as temperature modification, the flushing and redeposition of sediments which occurs during spring runoff, the import of particulate organic carbon and drifting insects from upstream areas, etc.

Although no significant differences were shown in species diversity, there were compositional changes in the partially regulated portion of the river. Mayflies were far more abundant in the control area (54 percent versus 27 percent), while stoneflies and dipterans showed higher densities in the partially regulated area (Plecoptera - 21 percent versus 15 percent; Diptera - 38 percent versus 24 percent). The composition of caddisflies was markedly different at the two sites, which is probably related to differences in periphyton and particulate organic carbon particle sizes of the seston. The timing of events in the life cycles of a number of species was different at the two main river sites; this can be correlated with seasonal temperature differences in the control and partially regulated areas of the river, which are due to discharges of hypolimnetic water from Hungry Horse Dam.

Annual means of individual counts (no./m^2) and biomass (cc/m^2) data indicate that densities of zoobenthos are higher in the South Fork (10,472 $\pm$ 6,372) than at the control (6,666 $\pm$ 6,144) and partially regulated (6,412 $\pm$ 7,078) sites. Overall, biomass is not significantly different at the three sites (control - 12.1 $\pm$ 4.2; partially regulated - 14.4 $\pm$ 9.0; regulated - 12.3 $\pm$ 5.8).

The ameliorative effects of the North and Middle Forks are limited when flows from natural areas are low. Major changes in the seasonal discharge regime from Hungry Horse Dam might substantially alter the composition of invertebrates in the main stem river and possibly affect the feeding habits and movement patterns of fish. Marked increases in discharge during certain seasons (e.g. sustained high winter flows) could cause species extinctions by increasing the winter heat load in the river and causing earlier emergences of certain species into lethal air temperatures. Preliminary data indicates that winter and early spring emerging species are abundant in the drift and provide a food source for trout. Also, high rates of discharge during dry summers could reduce or eliminate species which require higher summer temperatures for growth and emergence. Until more information is available on what environmental factors are important for the maintenance of a habitat suitable for important fish food species, caution should be exercised in altering discharge regimes. Recommendations and probable changes which may accompany particular operational options will be detailed in the Final Report.

ACKNOWLEDGEMENTS

Robert Schumacher, Regional Fisheries Manager, was instrumental in developing this study. Delano Hanzel, Montana Department of Fish, Wildlife and Parks, assisted in the hiring of personnel and with arrangements for computer analyses. Jack Stanford provided for the use of the University of Montana Biological Station facilities, equipment and stonefly reference collection.

We are indebted to William Perry, who has worked as a volunteer on the project for the past year, enumerating invertebrates, supervising personnel, and assisting with data calculations and graphics. Paul Leonard and Ken Frazer assisted with field work and graphics. We are indebted to employees of the CETA and YACC programs for their assistance in the collection and sorting of insects. Among the people who spent many tedious hours sorting insects were: Dave Arland, Dennis Barrow, John Bender, Nita Davis, Debbie De Gennaro, Laurie Dollan, Dave Donaldson, Buddy Drake, Sandy Entzel, Kirk Fallon, Mark Gaub, Emmie Ibison, Wanda Jamieson, Rick Johnson, Susan Kraft, Cathy Leddy, Robert Post, Chuck Richardson, Betty Schroder, Cathy Schloeder, Terry Seliger, Wendy Senger, Arlene Sinclair, John Squires, Jill Stanley, Ron Tate and Ande Wood. Dave Donaldson and Rick Johnson did the bulk of the volumetric measurements for biomass estimates.

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INTRODUCTION

The benthic invertebrate study was begun in June 1979, as part of a larger fisheries study to assess the impacts of various proposed power alternatives and operating regimes on the aquatic biota in the Flathead River. Hungry Horse Dam, which is located 8 km upstream from the mouth of the South Fork of the Flathead River, was completed in 1953. It is operated for flood control and power production by the Bureau of Reclamation. The crest of the dam is 1087 m above sea level. Four penstocks are located 75 m below the crest.

The present minimum flow from Hungry Horse Dam is 4.2 m^3/sec (150 cfs) and peak discharge is approximately 323 m^3/sec (11,417 cfs). The Bureau of Reclamation is assessing several alternatives which would increase peaking capacity and total annual power production. These include uprating the existing generators, a powerhouse addition, and the construction of a reregulating dam which would have an estimated storage capacity of 2.4×10^6 m^3. Maximum discharge from the existing dam could be increased to 390 m^3/sec.

The aquatic invertebrate study was undertaken to provide baseline information on community composition, species diversity, biomass, and life history characteristics of macroinvertebrates in the Flathead River above and below the confluence of the South Fork and in the South Fork of the Flathead River downstream from Hungry Horse Dam. The impact of operating regimes which have been proposed to enhance the fishery are being assessed with regard to their effect on the fish food organisms. Recommendations will be based on optimizing flows which 1) cause the least catastrophic invertebrate drift and stranding; 2) provide the most insect habitat; and 3) provide the best criteria for the growth and emergence of important fish food species. The objectives of the invertebrate study are:

1. To sample the benthos at monthly intervals over a two-year period in order to compare invertebrate densities and biomass in control and regulated areas of the Flathead River.

2. To assess differences in community composition in control and regulated areas with the use of diversity indices and ordinations techniques.

3. To (seasonally) study the food habits of whitefish and trout in regulated and control areas of the river and to ascertain whether certain species are feeding selectively on the drift or on the bottom.

4. To determine experimentally whether different rates of increases in discharge and times of shutdown at Hungry Horse Dam differentially affect invertebrate drift.

5. To assess the effect of regulation and of different discharge regimes on the rates of growth and times of emergence of selected aquatic insect species.

The construction of Hungry Horse Dam has resulted in a number of downstream modifications which are of significance to river zoobenthos. Dams can exert profound perturbative influences on the downstream riverine environment, and rapid, short-term fluctuations due to hydropower production have profoundly altered biological processes in the South Fork. Unpredictable and fluctuating flow conditions below dams with operational schedules based primarily on power needs have a detrimental effect on the benthos by inducing catastrophic drift, causing stranding, and altering the habitat. The manipulation of discharge affects the total lotic ecosystem. Certain changes in the discharge regime from dams can benefit invertebrate populations (high minimum flows, predictable flows, selective withdrawal systems, etc.). Water discharge is a factor of key importance to the benthos, especially due to its influence on temperature, current velocity, composition of the substrate, and the availability of food (Henricson and Müller 1979).

Temperature is an important environmental factor affecting the benthos in the regulated areas of the Flathead River. The hypolimnial releases from Hungry Horse Dam have stabilized temperatures in the South Fork; the yearly thermal regime is severely altered, varying only from 3° C to 7° C. The marked reduction in thermal amplitude in the South Fork as compared to the unregulated North and Middle Forks for the 1980 water year is shown in Figures 1 and 2. The lack of appropriate thermal criteria for hatching, growth and emergence may be the major factor contributing to the absence of many species of insects in the South Fork (Stanford 1975).

In general, environmental heterogeneity and biotic diversity will be reduced near an upstream impoundment, but will show a progressive recovery with increasing distance downstream (Ward and Stanford 1979). This recovery occurs abruptly in the Flathead River where the South Fork joins the unregulated North and Middle Forks. Because the ameliorative effect imposed by unregulated segments is much greater than in many regulated rivers, the main stem Flathead River will be referred to as partially regulated. The main stem Flathead River is affected by the addition of waters from the regulated South Fork, but the adverse effects on the macroinvertebrates are greatly tempered due to dilution by the North and Middle Forks.

The partially regulated Flathead River also shows the late fall and winter elevation (Figure 3) and summer depression (Figure 4) in river temperatures, although to a lesser extent than the South Fork. In the partially regulated areas of the river, severe thermal fluctuations over short periods of time may occur as power releases peak and wane. In the summer during periods when there is no generation, river temperatures warm quickly, since most of the flow is from the North and Middle Forks.

Discharges from Hungry Horse Dam also affect the availability of food for macroinvertebrates (Perry, in progress). The lack of trophic diversity contributes to the severely altered invertebrate composition in the South Fork. The South Fork supports a dense growth of periphytic

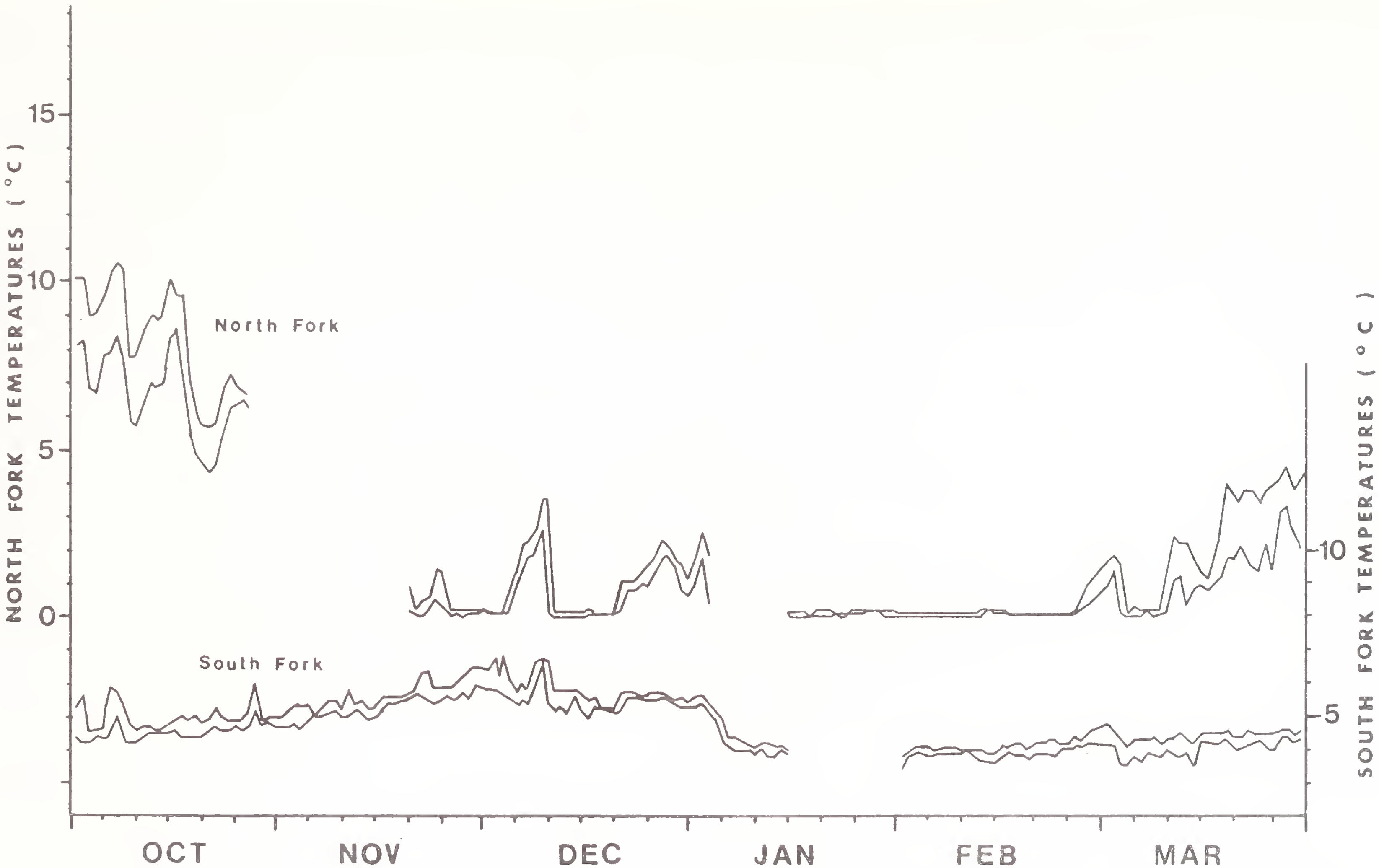


Figure 1. Daily maximum and minimum temperatures recorded at USGS stations on the North (unregulated) and South (regulated) Forks of the Flathead River from October, 1979 through March, 1980.

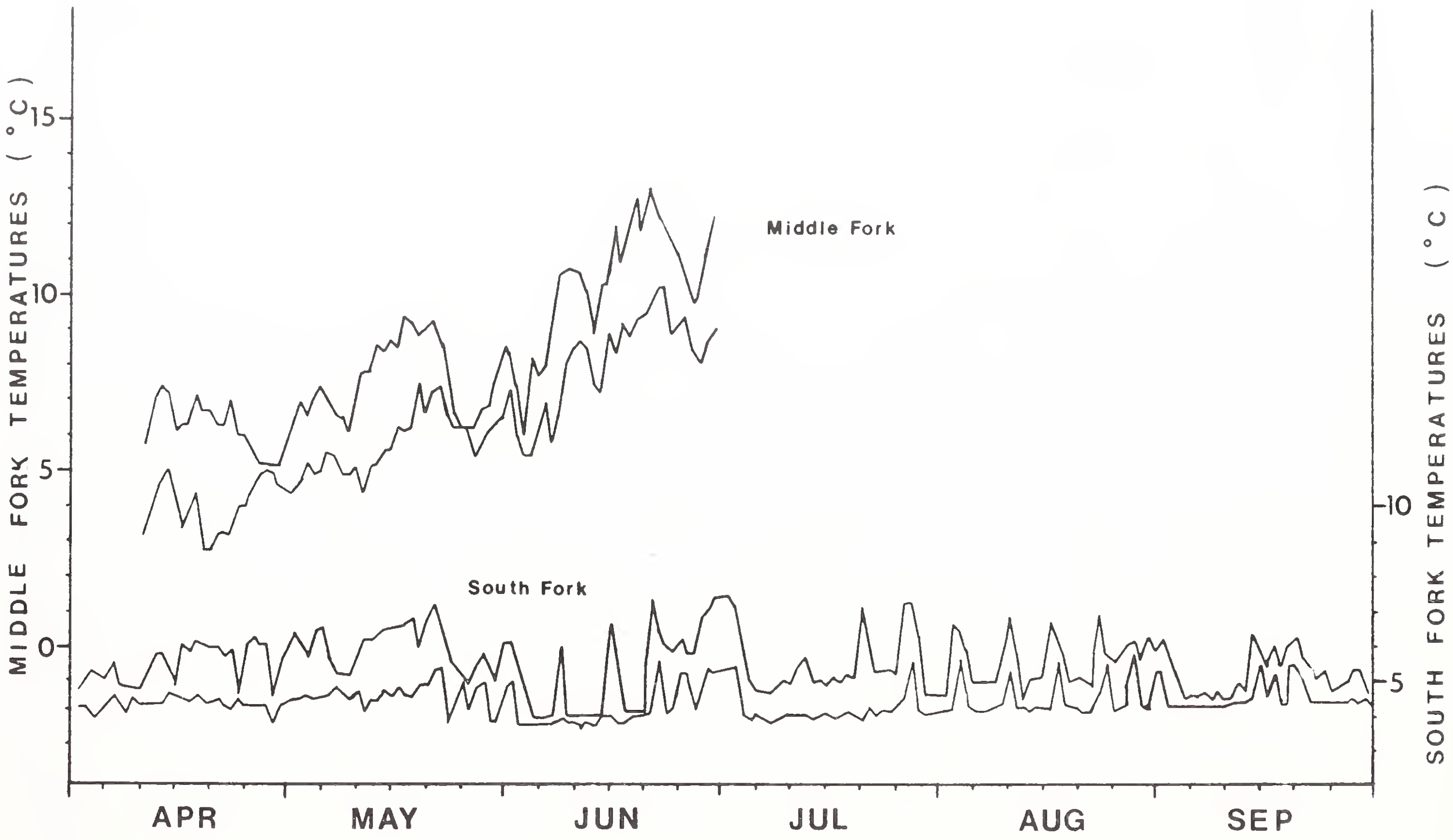


Figure 2. Daily maximum and minimum temperatures recorded at USGS stations on the Middle (unregulated) and South (regulated). Forks of the Flathead River from April through September, 1980.

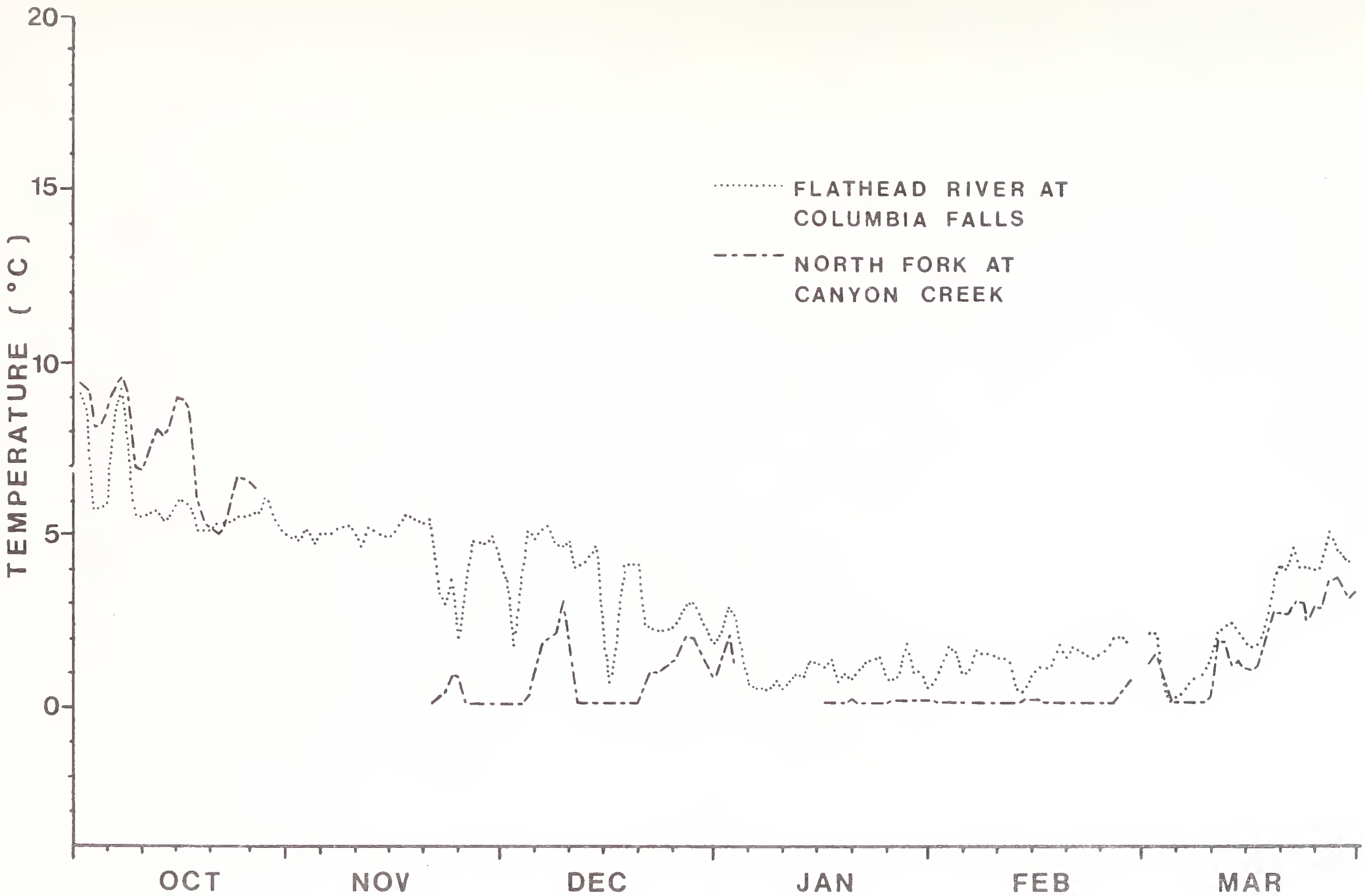


Figure 3. Mean daily temperatures recorded in the unregulated (North Fork) and partially regulated (Columbia Falls) areas of the Flathead River, October, 1979 through March, 1980.

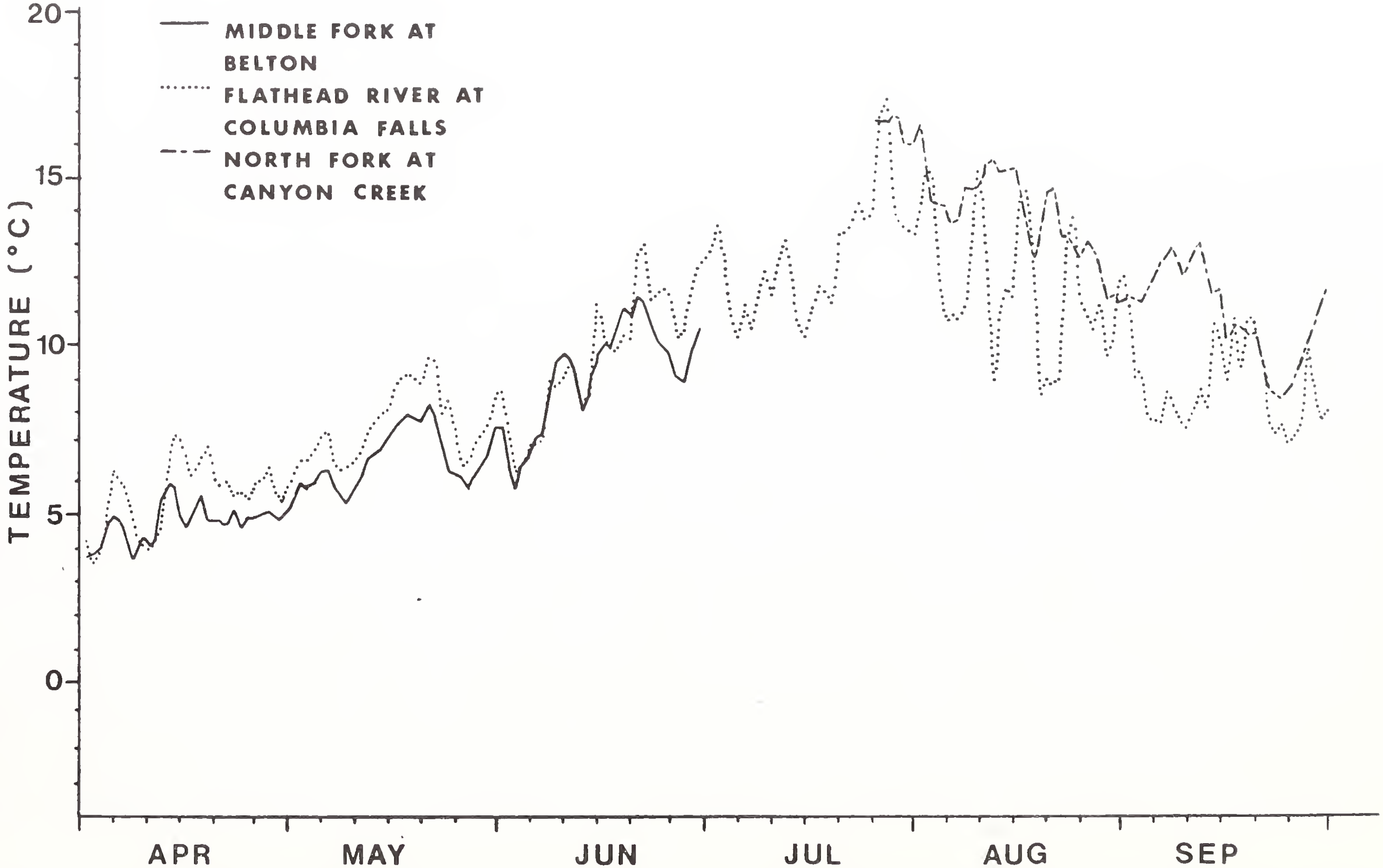


Figure 4. Mean daily temperatures recorded in the unregulated (North and Middle Forks) and partially regulated (Columbia Falls) areas of the Flathead River, April through September, 1980.

algae in the permanently wetted area of the river. Inorganic sediments settle out in the reservoir, reducing turbidity and sediment scour in the South Fork and main stem Flathead River, thus allowing increased periphyton growth. Seston from the reservoir is not abundant in the South Fork, since water is withdrawn only from the unproductive hypolimnion of the reservoir. Organic carbon is more abundant in the partially regulated areas of the Flathead River due to input from the unregulated forks and recruitment of debris from shoreline areas during generation (Perry, in progress).

Regulation also affects the composition of streambed materials and thus reduces habitat diversity. Natural areas of the Flathead River are characterized by loosely compacted flood plain materials composed of large cobble interspersed with smaller gravels and sand. In the South Fork, the smaller materials have been removed from the surface layer of rocks by the clearwater discharges from Hungry Horse Dam. The reservoir acts as a settling basin for inorganic materials, so there is no redeposition of the finer gravels and sand in the tailwater area. Substrate particle size has been shown to have an important effect on community structure (Cummins 1966; de March 1976; Minshall and Minshall 1977; Williams 1980).

STUDY AREAS

The Flathead River drains 21,876 km^2 of southeast British Columbia and northwest Montana. It is the northeastern most drainage in the Columbia River Basin. Three forks of approximately equal size drain the west slope of the Continental Divide. The South Fork flows out of the Bob Marshall Wilderness area to Hungry Horse Reservoir, a deep-storage impoundment approximately 66 km long with a storage capacity of 4,268 x 10^6 m^3. Discharge from Hungry Horse Dam varies from a minimum flow of 4.2 m^3/sec to a peak discharge of 323 m^3/sec, and vertical water level fluctuations in the South Fork downstream from the dam can vary as much as 2.5 m daily. The South Fork is grossly altered for its entire course (8 km) before it joins with the North and Middle Forks of the Flathead River. The hydrograph of the main stem Flathead River below the confluence with the South Fork is determined by the sum of the discharge from the three forks. Peak flows in the main stem normally occur in May and June, coinciding with peak runoff in the North and Middle Fork drainages. Except for peak runoff periods, the hydrograph of the main stem parallels that of the South Fork (Figures 5 and 6).

The macroinvertebrate work has been concentrated in riffle areas at three study sites: 1) South Fork of the Flathead River - 7.4 km from Hungry Horse Dam near the mouth of the South Fork; 2) Glacier Bible Camp (Control Site) - 1.2 km north of the mouth of the South Fork; and 3) Kokanee Bend Fishing Access Site - 12 km south of the mouth of the South Fork in the partially regulated main stem Flathead River (Figure 7).

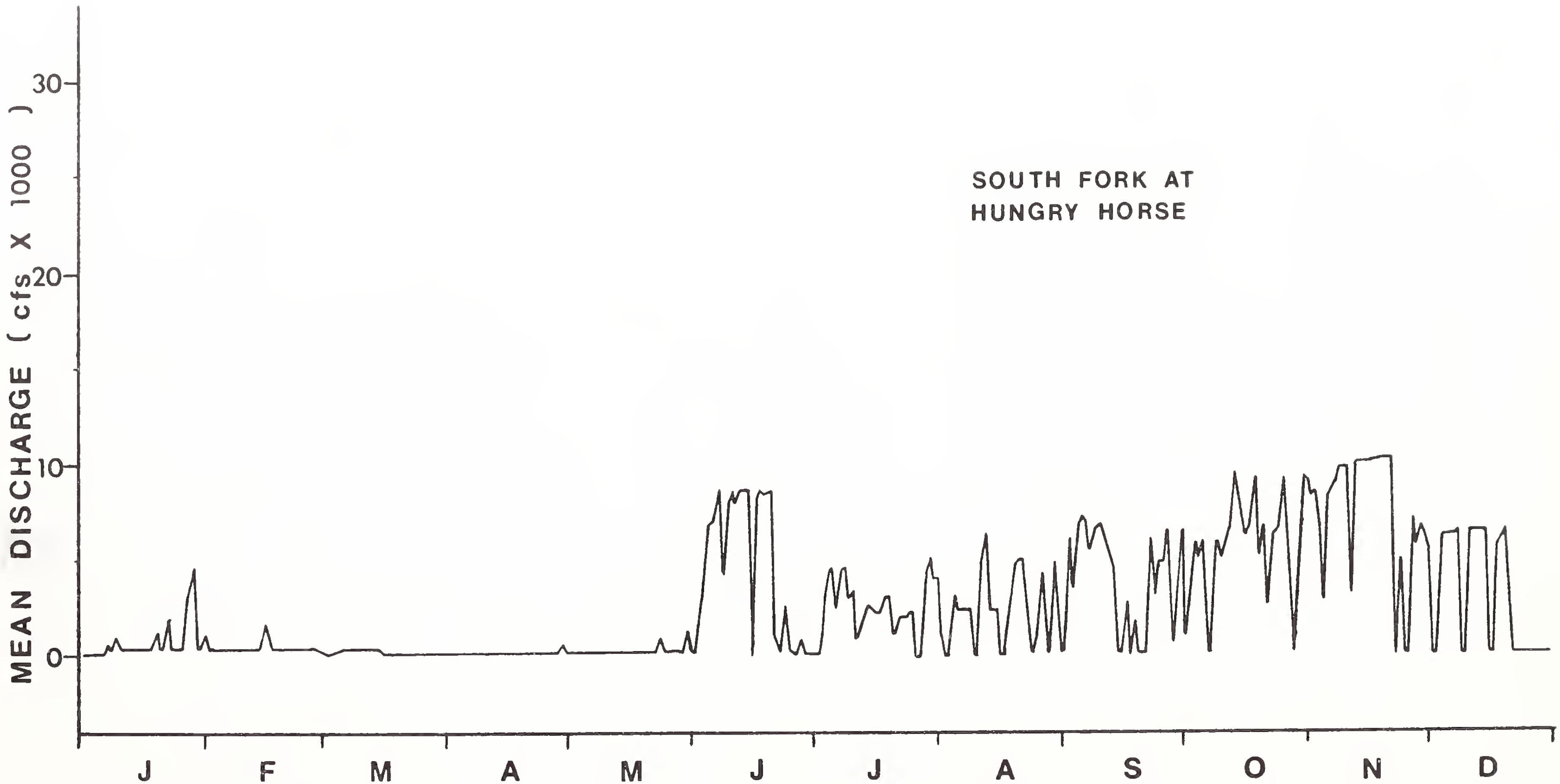


Figure 5. Mean daily discharge recorded in the South Fork of the Flathead River during the 1980 water year.

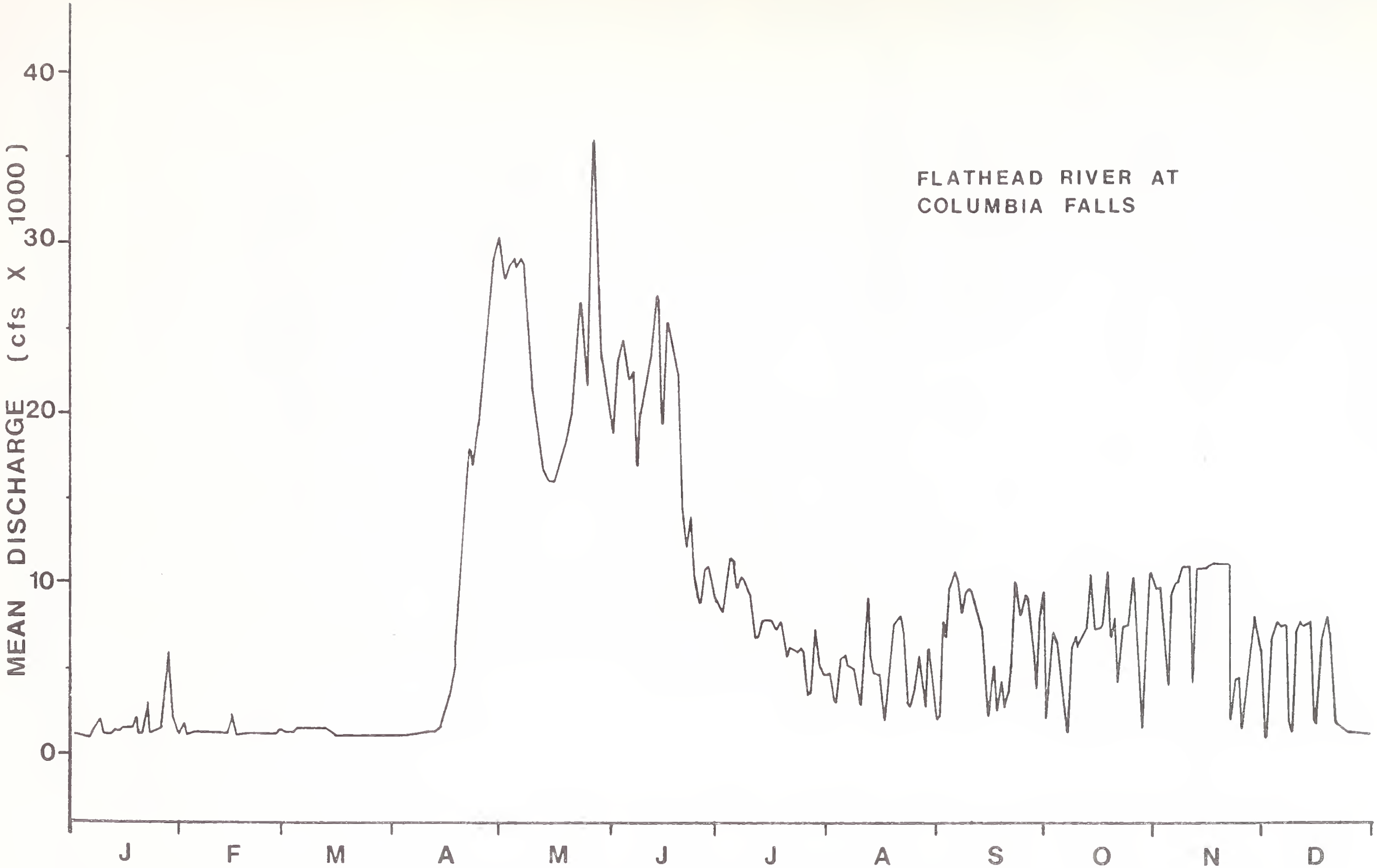


Figure 6. Mean daily discharge recorded in the partially regulated Flathead River (Columbia Falls) during the 1980 water year.

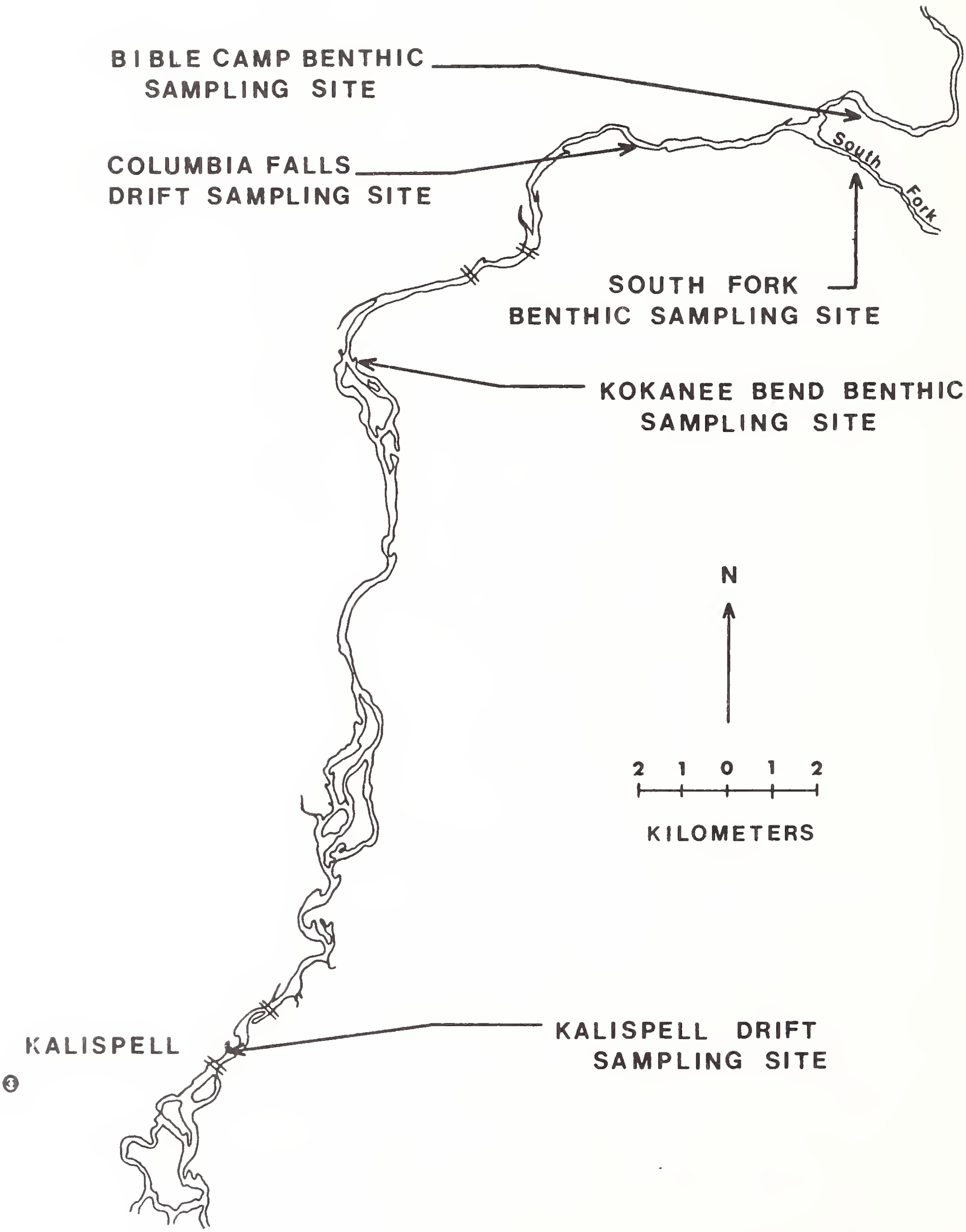


Figure 7. Macroinvertebrate sampling sites in the main stem and South Fork Flathead Rivers, 1979-1980.

METHODS

Monthly sampling of benthic invertebrates at the three established sites was begun in July, 1979. Eight to ten samples were taken at each site each month through September, 1980, by a combination of systematic sampling (the transect method) and stratified random sampling (selection of habitat types). Starting in October, 1980, the sample number was reduced to three samples per month at each of the three sites until sampling was terminated in April, 1981.

All samples were taken at conditions of minimum discharge from Hungry Horse Dam (4.2 m^3/sec in all months but January and February, 1980, when minimum flows were 12.7 m^3/sec). The maximum depth which was generally sampled was about 25 cm, which excluded animals living deeper in the substrate. Mean current velocity (taken with a Price AA current meter at the 0.6 depth) and water depths were taken just upstream from each benthic sample.

Two different samplers were used in an effort to reduce biases associated with any one sampling device. Sampling in the Flathead River was difficult due to the large substrate sizes, so conventional samplers had to be modified. Both samplers enclose a sample area of one-third m^2 and have a small mesh size (150 um) for retaining small instars of insects.

The modified kick net consisted of an outer rectangle 97 cm wide and 89 cm high made of Nitex with a 355 um mesh and bordered with canvas. A bag (72 cm long, 150 um mesh) with an opening 44 cm by 42 cm extended from the rectangular portion of the net. The net was held downstream from the sampling area which was delineated by a square made of one-quarter inch strap iron and encompassed one-third m^2. The net was curved around the square with the bottom taut during sampling. Rocks in the sample area were individually lifted inside the bag and brushed clean by hand. After all of the larger rocks were removed, the collection area was disturbed by kicking for 15 seconds. Organisms were retained in a clear acrylic bucket (with a drain made of Nitex with a 150 um mesh) at the cod end of the net.

The other sampler employed in this study was a circular depletion sampler described by Carle (1976). It functioned more efficiently at faster current velocities. The height of our sampler was 54 cm and the inside circumference and diameter were 205 and 65 cm, respectively. The collecting net was made of Nitex with 150 um mesh. Our sampler was made of aluminum, which was flexible and allowed the sampler to be wedged in around large rocks. Heavy rubber was riveted to the bottom of the sampler to provide a seal. An exact sample site was chosen by attempting to find a location where large rocks did not intersect the sampler edge. The sampler was then rapidly thrust down and turned into the substrate. If the sampler could not be stabilized and sealed within a few seconds by moving rocks, the site was abandoned. The procedure

was the same as with the kick net, brushing all the large rocks and removing them and then kicking the substrate within the sampler for 15 seconds.

Organisms were preserved in 10 percent formalin to which Rose Bengal stain had been added. Macroinvertebrates were handpicked from the algae, detritus, and inorganic material, sorted to order and placed in vials containing 75 percent alcohol. The larger insects were removed (greater than 2 mm in length) and then a one-quarter or one-eight subsample was taken. The subsample was completely picked with the aid of a microscope. All insects were identified to the lowest taxonomic level possible and enumerated using a laboratory counter. A number of workers were employed to sort samples, so quality control procedures were adopted to insure consistency. All samples were checked by a supervisor and subsampling methods were standardized.

Biomass was measured by volume displacement, with any volume less than 0.1 ml assigned a trace value of 0.05. Volumetric measurements were made with the use of a 50 milliliter burette and a graduated centrifuge tube.

Three drift nets were constructed of heavy materials to accommodate changes in discharge and large enough to adequately sample when drift rates were low. These nets had a rectangular opening measuring 45.7 by 30.5 cm and a Nitex bag with 355 um opening which was 1.5 meters long. The frame was made of angle iron with holes for steel rods which were driven into the substrate. Rubber flanges projecting backward from the edge of the net prevented large insects from walking out of the net.

Adult insects were collected by hand, with sweep nets, in pit traps (buried cans containing formalin covered with a thin film of diesel fuel), and with light traps (containing uv fluorescent lights used with a battery which was operated by a photocell or used with 110 volt A.C.). Six pit traps were in position at the three sites from March to August, 1980. Light traps were operated nightly from June to October, 1980, at the control and partially regulated sites.

Water samples were collected on a monthly basis from November, 1979, to November, 1980. Chemical parameters measured on water samples from the South Fork included total suspended solids (gravimetric), particulate and dissolved organic carbon (International Oceanography Total Organic Carbon Analyzer), Na^+, K^+, Ca^{++}, Mg^{++}, NO_3^-, $SO_4^=$ (ion exchange chromatography Dionex Corporation), and total P (Standard Methods). The analyses were conducted by the Analytical Services Group of the Freshwater Research Laboratory at the University of Montana Biological Station.

Flow data and continuous recording thermograph data which are collected by the U.S. Geological Survey were obtained for the South Fork, North Fork, and main stem Flathead River at Columbia Falls.

Species diversity was compared at six sites on the Flathead River using Shannon and Brillouin diversity indices. They were calculated using data collected during the months of October and December, 1979 and March and July, 1980, at the South Fork, Kokanee Bend and Bible Camp sample sites. Data collected for the fish food habits study (three kick samples per site per month taken at Columbia Falls and Kalispell during March, July and October, 1980) as well as six kick samples collected in October, 1980 at Spotted Bear (above Hungry Horse Reservoir) were also used to calculate diversity indices (Table 1). Samples were pooled by sampler type at each sample location and date. Values obtained by using the two indices were almost identical, so only the Shannon Index will be discussed.

The formula used for the Shannon function was $H' = \sum_{i}^{s} \left(\frac{Ni}{N}\right) \log_2 \left(\frac{Ni}{N}\right)$ where s = number of taxa in sample, N_i = number of individuals in taxon i, and $N = \sum_{i}^{s} N_i$. A value of zero is obtained when all individuals belong to the same species. The maximum value of H' depends on the number of individuals counted and is obtained when all individuals belong to different species. H' usually varies between three and four in natural stream areas and is usually less than one in polluted or stressed stream areas.

Evenness (E_v), as measured by Margalef (1957) is a ratio of the observed H' to a maximum theoretical diversity (H'_{max}) computed with all individuals equally distributed among the species. Maximum diversity (H'_{max}) was computed as $\log_2 s$; therefore evenness = $\frac{H'}{\log_2 s}$. Evenness generally ranges between 0 and 1. Perturbation reduces E_v below 0.5 and generally to a range of 0.0 to 0.3.

RESULTS AND DISCUSSION

To date, 369 quantitative benthic samples have been picked and analyzed numerically and volumetrically. An additional 63 benthic samples from the second year of the study have been collected and picked.

Species Diversity

The benthic invertebrate composition was grossly different in the South Fork than at the main stem stations. Species diversity was low in the South Fork. Reductions in species diversity in the tailwater areas downstream from hypolimnial release reservoirs have been found by a number of researchers (e.g. Pearson et al. 1968; Hilsenhoff 1971; Hoffman and Kilambi 1971; Spence and Hynes 1971; Fisher and Lavoy 1972; Lehmkuhl 1972; Ward 1974, 1976; Young et al. 1976). The fauna in the South Fork was dominated by the dipteran family Chironomidae (Appendix C). Reproducing populations of turbellarians, nematodes, oligochaetes, and water mites were also present. A few other insect species probably

Table 1. Shannon Diversity Indices

		October		December		March		July			
		Kick	Circular	Kick	Circular	Kick	Circular	Kick	Circular	$\bar{x}$	s.d.
South Fork	H'	0.22	0.17	0.6	0.22	0.97	1.0	1.79	1.15	0.8	(0.6)
	Ev	0.06	0.06	0.14	0.05	0.22	0.24	0.37	0.26	0.18	(0.12)
Columbia Falls	H'	3.32				2.65	2.33	3.3		2.9	(0.5)
	Ev	0.63				0.57	0.45	0.61		0.57	(0.08)
Kokanee Bend	H'	3.05	3.17	3.18	3.26	2.99	3.08	3.7	3.64	3.3	(0.3)
	Ev	0.59	0.59	0.62	0.61	0.59	0.61	0.67	0.72	0.63	(0.05)
Kalispell	H'	3.33				2.93		3.51		3.3	(0.3)
	Ev	0.64				0.60		0.72		0.65	(0.06)
Bible Camp	H'	3.07	2.81	3.16		2.79	2.96	3.42	3.4	3.1	(0.3)
	Ev	0.57	0.57	0.59		0.53	0.57	0.64	0.65	0.59	(0.04)
Spotted Bear	H'	3.23								3.25	
	Ev	0.57								0.57	

complete their life cycles under the constant temperture conditions that exist in the South Fork, although their populations were very small. These included the stoneflies, *Zapada columbiana*, *Zapada cinctipes*, *Capnia spp.*, *Utacapnia spp.*, *Taenionema pacificum*, *Sweltsa sp.*, and *Diura knowltoni*, the mayflies *Baetis tricaudatus*, *Baetis bicaudatus*, *Rhithrogena robusta*, *Cinygmula sp.* and *Epeorus grandis*, the caddisfly *Rhyacophila verrula*, and the dipteran *Simulium arcticum*.

To date, a total of 45 species of insects have been collected in the South Fork. Because only one or a few individuals of many of these species were collected, it is unlikely that they have reproducing populations in the South Fork. Many of these probably drifted downstream from Fawn Creek, a tributary of the South Fork. Some of the species collected in the South Fork were characteristic of smaller streams like Fawn Creek and have not generally been reported in rivers as large as the Flathead River. Many of these species may exist in the South Fork because they are adapted to the colder, more constant temperatures found in headwater streams.

In contrast to the South Fork, both the control and partially regulated stations on the main stem Flathead River had diverse insect faunas. To date, 71 species have been identified at the control site and 70 species at the partially regulated site. The species list at each site will be much higher after adult collections have been identified (many insects cannot be identified to species in their immature stages). Species lists for the control and partially regulated sites were similar, but there were a number of differences in the abundance of species at the two sites.

Species diversity was compared at six sites on the Flathead River using the Shannon diversity index. The mean of the diversity indices for the four seasons for which they were calculated was 0.8 at the South Fork station and generally 3.1 to 3.3 at the main river sites (Table 1). Thus no significant differences in overall diversity were shown between the control and partially regulated sites. Differences in composition were found between the main river sites, but diversity indices do not take into account the species involved. Although diversity has been considered an intrinsic property of communities, the more recent view is that it is too vague (Hurlbert 1971) and that the two components (species richness and equitability) often vary independently (Moore 1975). Ordination and clustering methods may be more informative methods for reducing biological data and arraying it spatially. Ordination techniques will be applied to the data using two computer programs from the Cornell Ecology Program series - DECORANA, a Fortran program for detrended correspondence analysis and reciprocal averaging (Hill 1979) and ORDIFLEX, a flexible computer program for four ordination techniques: weighted averages, polar ordination, principal components analysis, and reciprocal averaging (Gauch 1977).

Abundance and Distribution

The 1980 water year (October 1979 to September 1980) was used for detailed comparisons of numbers (no./m^2) and biomass (cc/m^2) at the three sample stations. Accurate quantification of numbers and biomass was difficult in a large, regulated river. With our sampling gear, it was possible to sample only at minimum flows near the shore in riffle areas. The highest densities were found near waters edge where current speeds were slower than those near the middle of the river. The Flathead River had an extensive hyporheic zone which could not be sampled. The channel and adjacent substrata were composed of loosely compacted flood plain gravels. Water circulated deep within the substrate and laterally from the river channel. This subterranean habitat was colonized by certain species of macrobenthos, in particular, a few species of stoneflies (Stanford and Gaufin 1974), which were collected only when they were near emergence.

The Bible Camp site was frozen during the winter and could not be sampled during January and February. Densities were low at the Kokanee Bend site during the winter months, suggesting that some species may have moved deeper into the substrate. It was also difficult to sample during the runoff period, although reasonably good samples were obtained at waters edge during June after the shoreline areas were recolonized. It was not possible to sample during May when the runoff began, because insects had not colonized recently wetted areas.

Mean numbers per square meter were calculated for each insect order at each site by month (Appendix A - Figures 16-27). The Chironomidae were treated separately due to the large numbers represented by this family of dipterans in regulated areas. The monthly means were averaged to give an annual mean (Table 2, Figure 8). The chironomids and oligochaetes dominated in the South Fork and the mayflies, stoneflies, and caddisflies were much reduced. The annual mean for the mayflies was much higher at the control site, but the annual mean numbers of the other orders were larger at the partially regulated site.

The annual mean number/m^2 of total macroinvertebrates was highest in the South Fork (10,472), but not significantly different at the Bible Camp (6,666) and Kokanee Bend (6,412) sites. The total number of invertebrates was most affected by the numerically dominant groups - the midges, blackflies, certain mayflies and large numbers of small instars of any of the common species. During most months the total number of invertebrates per square meter was highest in the South Fork (Figure 9). Differences between the Bible Camp and Kokanee Bend sites were due to compositional shifts and differences in the timing of life cycles at the two sites.

Density Estimates

The mean monthly densities of the three insect orders more sensitive to perturbation were graphed for the South Fork (Figure 10), Kokanee

Table 2. Densities ($\bar{x}$ no./m²) (Kick + Circular Samples)
Annual Mean of Monthly Means (October 1979 - September 1980)

	Bible Camp n=9 $\bar{\bar{x}}$(s.d.)	Kokanee Bend n=9 $\bar{\bar{x}}$(s.d.)	South Fork n=11 $\bar{\bar{x}}$(s.d.)
Ephemeroptera	3,608(1,789)	1,738(899)	330(193)
Plecoptera	990(1,201)	1,335(1,753)	76(37)
Trichoptera	374(332)	522(483)	8(7)
Chironomidae	1,427(534)	1,739(992)	8,931(3,078)
Other Diptera	194(359)	708(1,465)	148(313)
Other Invertebrates	74(56)	370(269)	979(344)
TOTAL	6,666(3,072)	6,412(3,539)	10,472(3,186)
Percent Composition	%	%	%
Ephemeroptera	54.1	27.1	3.2
Plecoptera	14.9	20.8	0.7
Trichoptera	5.6	8.1	0.08
Chironomidae	21.4	27.1	85.3
Other Diptera	2.9	11.0	1.4
Other Invertebrates	1.1	5.8	9.3

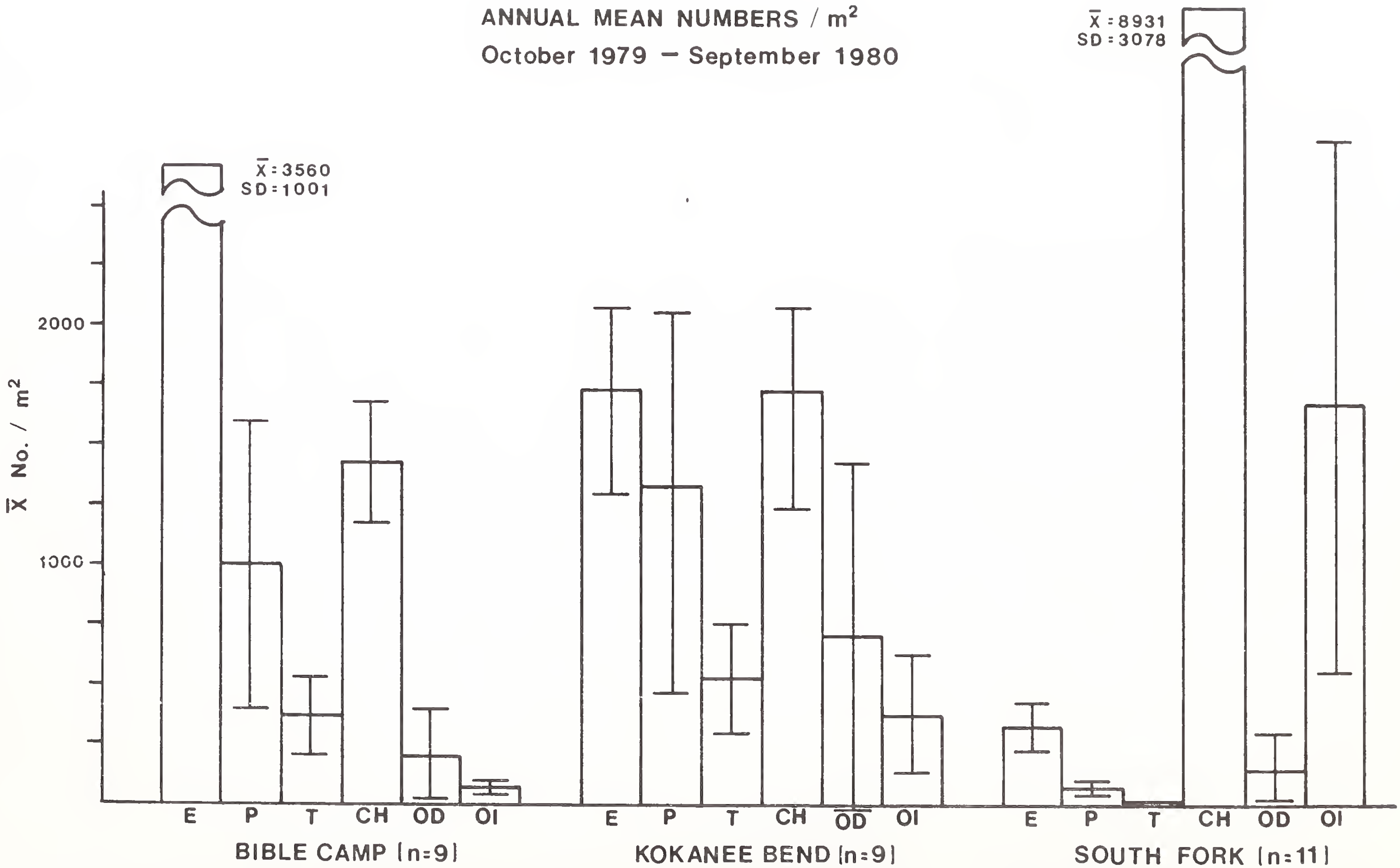


Figure 8. Mean number of invertebrates per square meter; annual means of monthly means. Bars represent means, I represents standard deviations. E = Ephemeroptera; P = Plecoptera; T = Trichoptera; Ch = Chironomidae; OD = Other Diptera; OI = Other Invertebrates.

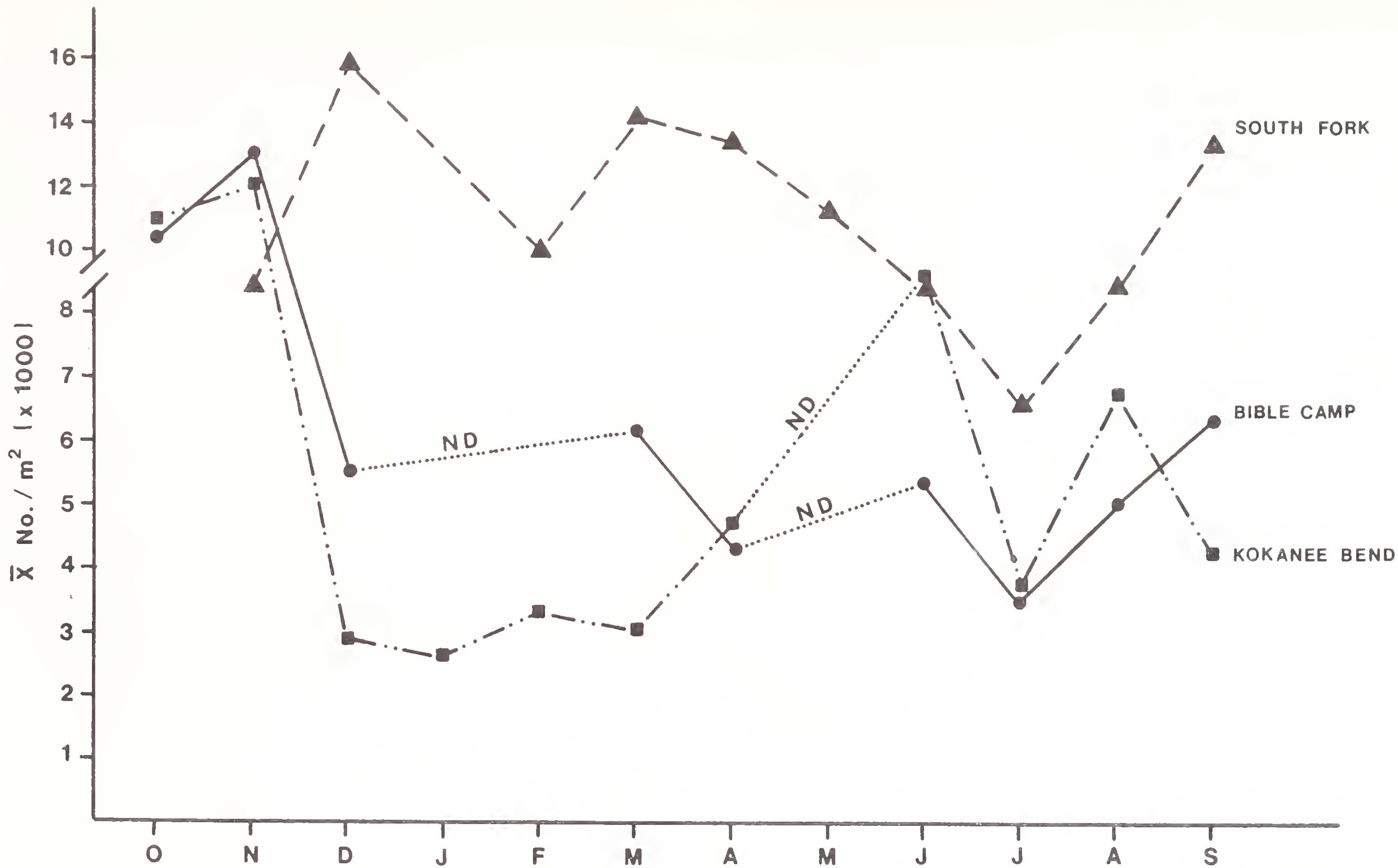


Figure 9. Mean numbers of total invertebrate per square meter, October, 1979 through September, 1980.

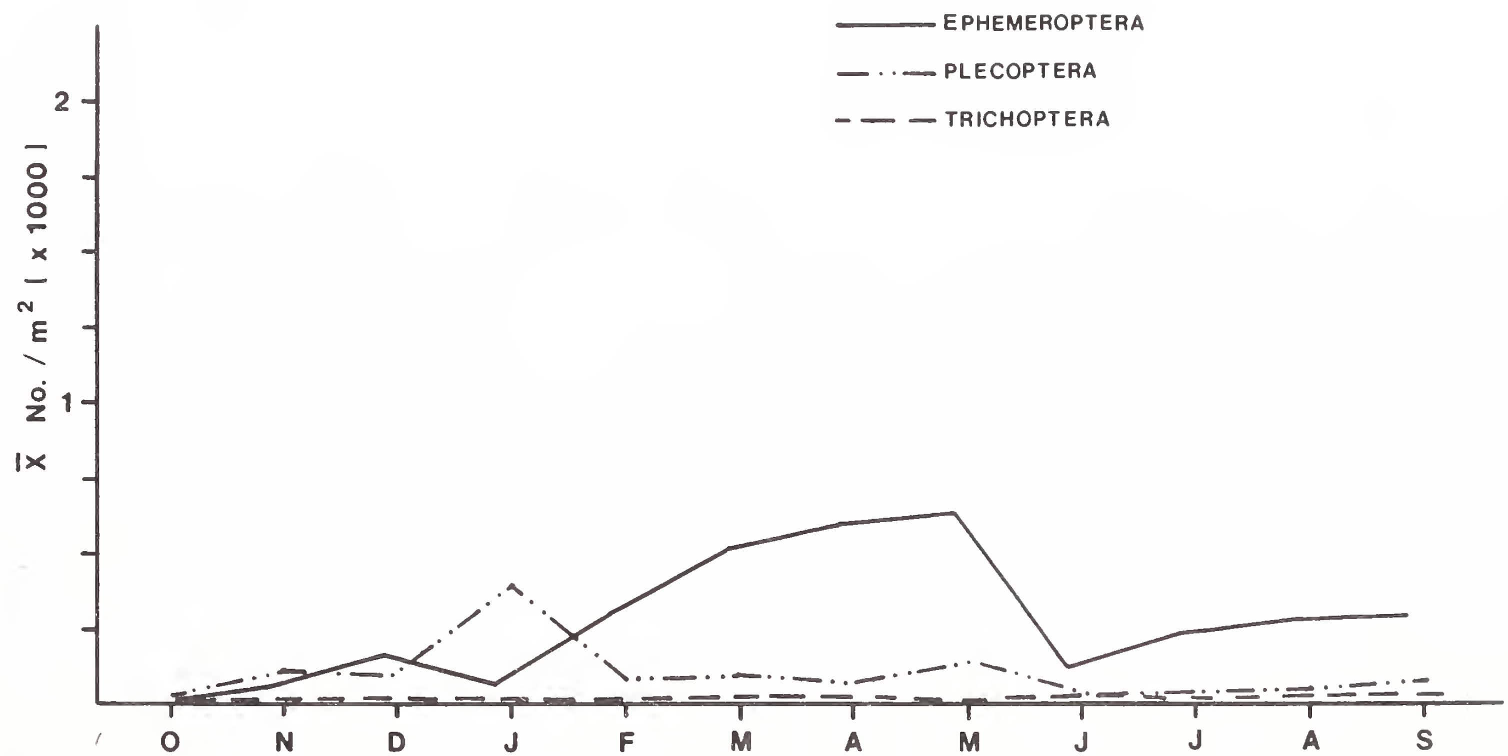


Figure 10. Mean number/m^2 of the insect orders Ephemeroptera, Plecoptera, and Trichoptera at the South Fork (regulated) sampling site, October 1979 - September 1980. N.D. = no sample taken.

Bend (Figure 11), and Bible Camp (Figure 12) study sites. Small densities of Plecoptera and especially the Trichoptera were found in the South Fork. The Ephemeroptera showed an increase from January to May. This may have been due in part to the lack of generation at Hungry Horse Dam during the winter months (Figure 5), which may have allowed thermally tolerant species to build up populations through drift from Fawn Creek. This winter maximum in mayfly numbers is shifted from the population maximum of Ephemeroptera in October and November at the other two sites (Figure 13). In part, it may reflect differences in the life cycles of the different species of mayflies which inhabit the South Fork and main river sites.

Number of Plecoptera and Trichoptera generally paralleled each other through time at the main stem sites (Figures 11 and 12). Numbers of these two orders of insects were generally higher at Kokanee Bend than at the Bible Camp. Ephemeroptera were collected in larger numbers at the Bible Camp than at the Kokanee Bend site (Figure 13). This trend was especially marked in December and March. The fall increase in these three orders at both sites reflected the life cycle pattern of the most abundant species. Many mayflies and caddisflies and some stoneflies emerged in the late spring, summer and early fall months. Numbers of these orders of insects tended to peak in October, then started to decrease as normal demographic events led to fewer, larger insects of many species.

Mayflies

The species lists were similar for the Bible Camp and Kokanee Bend sites, but a number of species showed marked changes in density at these sites (Tables 3 and 4). Most mayfly species were more abundant at the control site. The reduction in mayflies at Kokanee Bend could indicate a reduction in fine particulate organic matter in the substrate. The clearwater discharges from the dam would remove the finer organic sediments on which some species of mayflies feed. Webster et al. 1979, developed a model of the effects of impoundment on organic matter transport which predicted no deposition of benthic particulate organic matter below the reservoir due to the fact that repeated rising discharges suspend smaller and lighter particles and transport them downstream. Many mayflies are found in the shallow water along waters edge during their early developmental stages. These shoreline areas were particularly affected by fluctuating flows.

Two of the common heptageniid species, *Rhithrogena hageni* and *Epeorus longimanus*, have their gills arranged to form a suction cup which assists in maintaining their position on rock surfaces. Rapid water fluctuations and increased algal growths probably impaired the efficiency with which they could maintain their positions in the boundary layer on the surfaces of rocks. Henricson and Müller 1979, suggested that those species of mayflies which overwinter as eggs or small quiescent nymphs deep in the substrate may be better pre-adapted to regulated conditions, since they are exposed to flow fluctuations for only a short time as active, full-grown nymphs. *Ephemerella tibialis* and *Pseudocleon sp.* fall into

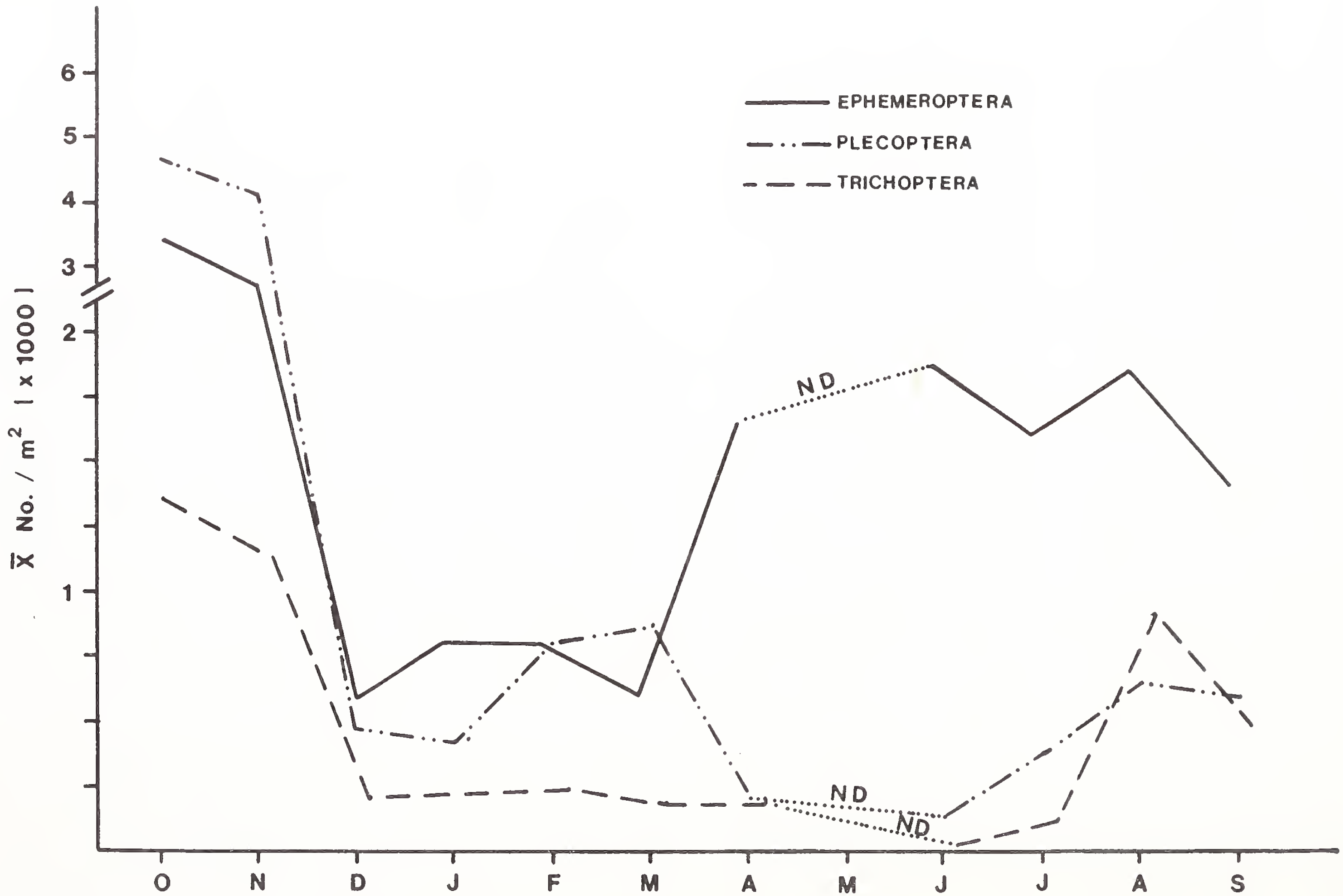


Figure 11, Mean number/m² of the insect orders Ephemeroptera, Plecoptera and Trichoptera at the Kokanee Bend (partially regulated) sampling site, October 1979 - September 1980; N.D. = no sample taken.

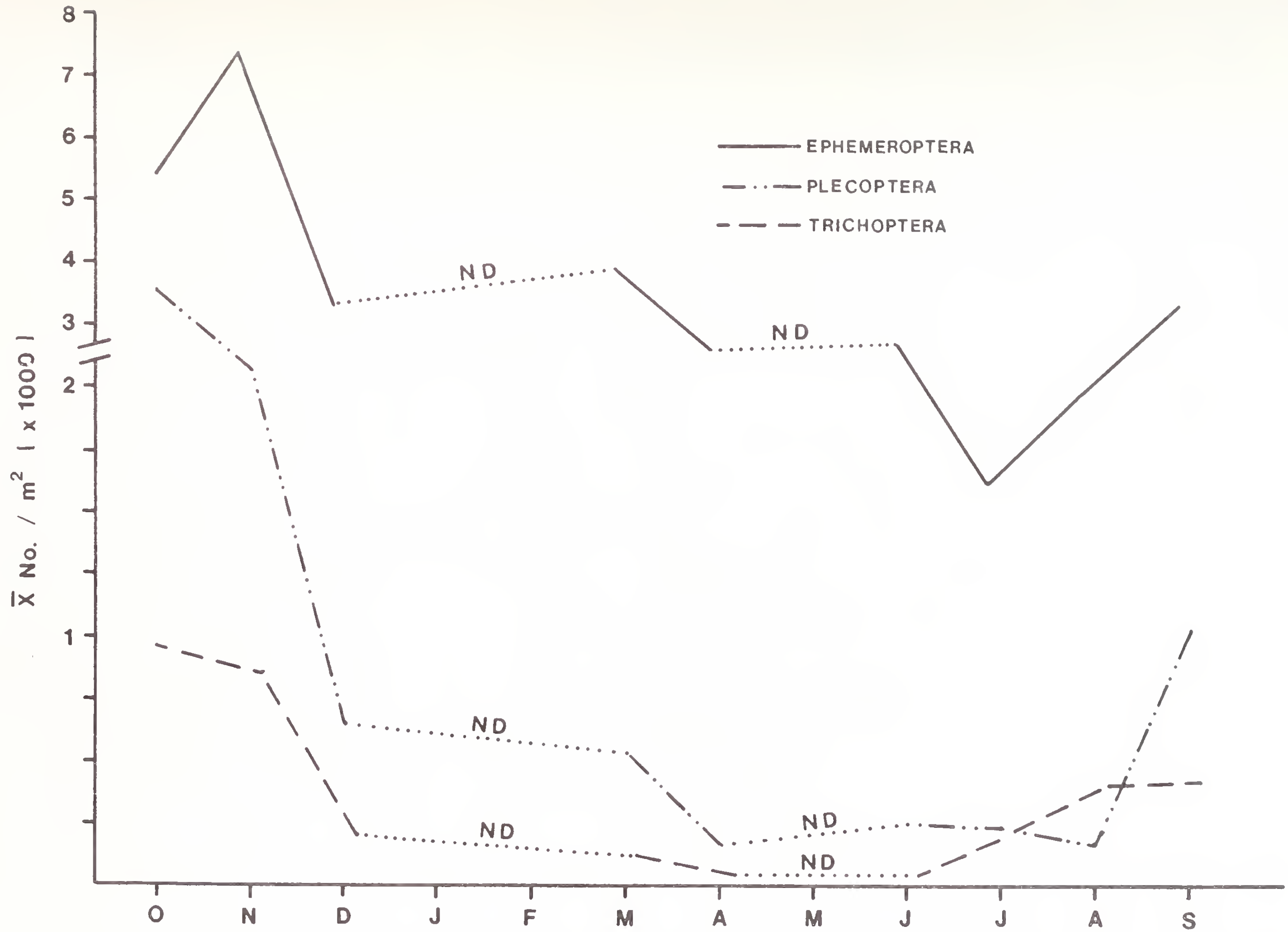


Figure 12. Mean number/m² of the insect orders Ephemeroptera, Plecoptera and Trichoptera at the Bible Camp (control) sampling site, October 1979 - September 1980; N.D. = no sample taken.

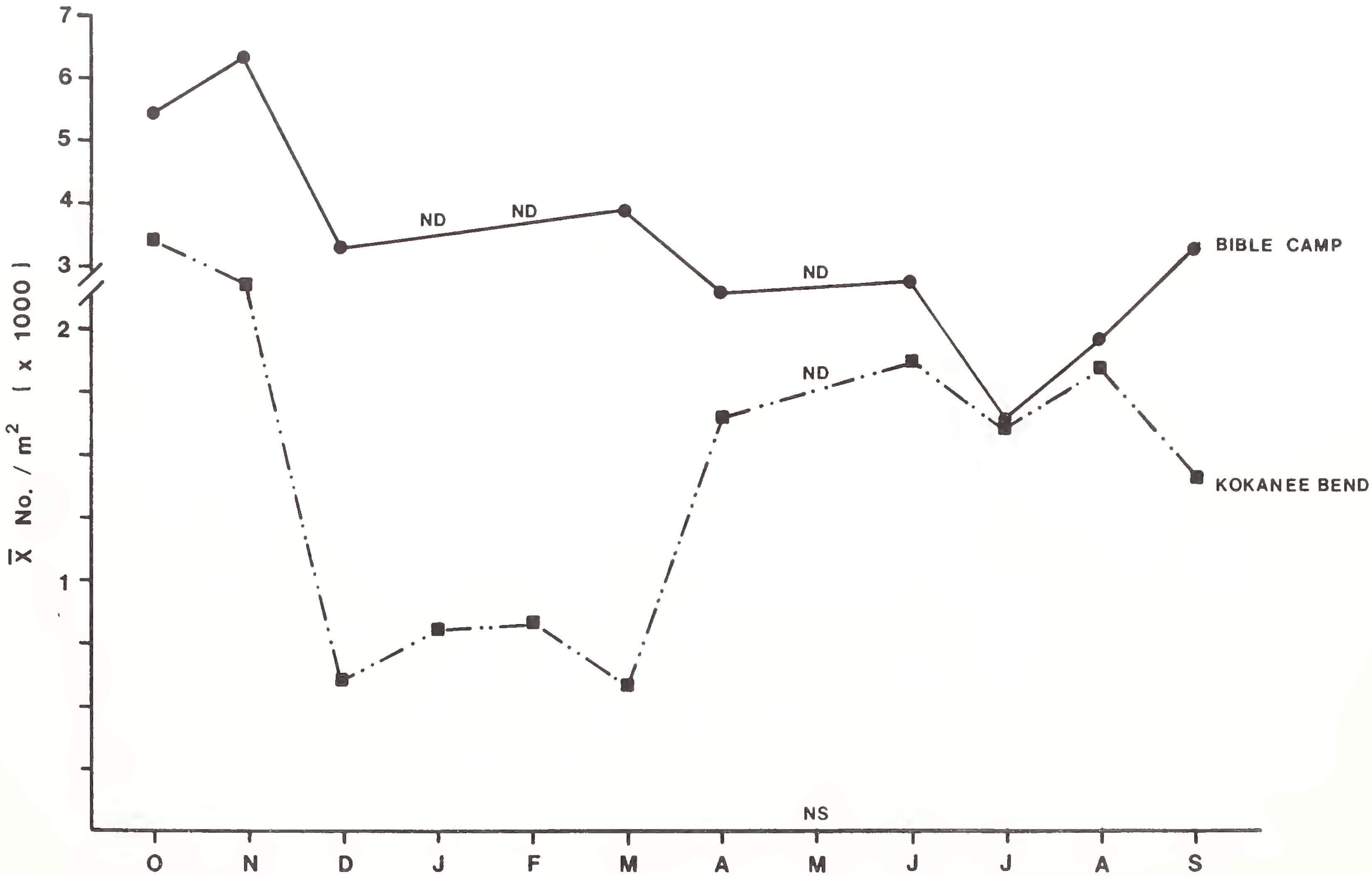


Figure 13. Mean number/m² of the insect order Ephemeroptera at the control (Bible Camp) and partially regulated (Kokanee Bend) sampling site, October 1979 - September 1980; N.D. = no sample taken.

Table 3. Macroinvertebrates with higher densities in the free-flowing Flathead River (Bible Camp sampling site). Annual mean number/m^2 (October 1979 - September 1980).

	Bible Camp $\bar{x}$(s.d.)	Kokanee Bend $\bar{x}$(s.d.)
EPHEMEROPTERA		
Baetis hageni	247(277)	43(75)
Rhithrogena hageni	1,079(910)	258(179)
Epeorus sp.	116(78)	37(85)
Ephemerella doddsi	59(58)	28(30)
Ephemerella inermis	198(188)	111(138)
Paraleptophlebia heteronea	36(36)	3(4)
TRICHOPTERA		
Symphitopsyche oslari	130(183)	20(36)
Symphitopsyche cockerelli	35(40)	11(15)
Hydropsyche occidentalis	33(42)	4(6)
DIPTERA		
Hexatoma sp.	7(9)	3(3)

Table 4. Macroinvertebrates with higher densities in the partially regulated Flathead River (Kokanee Bend sampling site). Annual mean number/m^2 (October 1979 - September 1980).

	Bible Camp $\bar{x}$(s.d.)	Kokanee Bend $\bar{x}$(s.d.)
EPHEMEROPTERA		
Ephemerella tibialis	80(96)	204(253)
PLECOPTERA		
Pteronarcella badia	27(56)	63(61)
Capniidae	174(144)	341(264)
Chloroperlidae	38(34)	104(84)
TRICHOPTERA		
Arctopsyche grandis	21(31)	190(248)
Glossosoma sp.	43(120)	234(385)
DIPTERA		
Atherix variegata	3(5)	7(9)
Simulium arcticum	196(449)	706(1,447)

this category and are the only mayfly species which were found in greater numbers at the Kokanee Bend site.

Stoneflies

A number of stonefly species do not show significantly different densities at the two main river sites. The families Capniidae and Chloroperlidae were found in larger numbers at the Kokanee Bend site. *Pteronarcella badia* also occurred in consistently larger densities at the Kokanee Bend site. It is a shredder which is often found in depositional areas. Wood and large particulate matter were collected much more frequently in our sample nets at Kokanee Bend and there are indications that course particulate organic matter was more abundant in the substrate in the regulated areas. This may be related to the fact that fluctuating flows can collect more debris from shoreline areas. After the spring runoff the river channel is removed from shoreline vegetation in unregulated areas.

Caddisflies

Caddisflies often show compositional changes in regulated areas (Henricson and Müller 1979). In the Flathead River, *Arctopsyche grandis* was much more abundant at the regulated site and the other hydropsychid species (*Symphitopsyche oslari, S. cockerelli, Hydropsyche occidentalis*) were more abundant at the control site (Tables 3 and 4). Hauer (1980) found the same relative abundances of these species in the free-flowing North and Middle Forks and further downstream in the partially regulated main stem river. *Arctopsyche* is a large particle feeder (mesh net openings generally vary from 400-500 um, Wallace et al. 1979). Carbon fractionation work has shown differences in available particle sizes at the two sites (Perry, in progress). It may also be that *Arctopsyche* is more resistant to current fluctuations (perhaps because their nets are stronger). *Glossosoma sp.* showed a marked increase in density at the regulated site. It is an algal scraper and is probably more abundant due to increased periphytic growth in the regulated areas (Perry, in progress). The saddle cases it constructs and firmly affixes to rock surfaces would also make it more resistant to displacement or desiccation due to flow changes.

Dipterans

Most dipterans were collected in greater numbers at the Kokanee Bend site (e.g. Blephariceridae, Deuterophlebiidae, *Antocha sp.*, *Atherix variegata*, *Protanyderus sp.*, *Simulium arcticum*, and the Chironomidae). The first two families have suckers which would enable them to hold on during velocity changes; they also are algal scrapers and periphyton was more abundant in regulated areas. *Atherix*, *Protanyderus* and many Chironomidae are burrowers which would not be as subject to catastrophic drift during the quick velocity changes due to regulation. *Simulium arcticum* abundances may be related to larger amounts of the smaller size fractions of particulate organic matter in the seston at Kokanee Bend.

Biomass Estimates

The annual mean of mean monthly estimates of biomass (cc/m^2) indicated that the total biomass of macroinvertebrates was not significantly different at the three sites. Kokanee Bend data showed slightly higher values on an annual basis (13.9) than the Bible Camp (11.9) and South Fork (11.9) data (Table 5, Figure 14). The Chironomidae and oligochaetes still dominated the fauna in the South Fork, but not by the overwhelming proportion that was characteristic of the data showing numbers per square meter. The biomass data from the Bible Camp and Kokanee Bend showed the same general trend on an annual basis as the numerical data. Biomass of mayflies was higher at the Bible Camp, biomass of stoneflies and caddisflies was higher at Kokanee Bend, and the Chironomidae and Other Invertebrate categories were not significantly different. Volumes of Other Invertebrates include other dipterans as well as non-insect invertebrates.

Numerical and volumetric data can be compared at the three sites by converting the actual mean monthly values to percent composition (Tables 6 and 7). In the South Fork, percent composition was much higher on a biomass than on a numerical basis for the Ephemeroptera, Plecoptera, Trichoptera, and Other Invertebrates.

In comparisons of the other two sites (Appendices A & B), the mayflies showed both higher numbers and biomass at the control sites in every month. Both numbers and biomass of stoneflies were generally higher at Kokanee Bend (with the exception of December, June and September when numbers were higher at the Bible Camp). Numbers and biomass of caddisflies were also generally higher at Kokanee Bend (with the exception of the months of June and July when numbers and biomass were higher at the Bible Camp, and the months of August and September when volumes were higher at the Bible Camp). The Chironomidae showed higher numbers and volumes at Kokanee Bend in the months of October, November, April, June and August and at the Bible Camp in December, March, July and September.

Ephemeroptera were the numerically dominant order at the Bible Camp in all months (Appendix A, Figures 16-27). Plecoptera were dominant numerically at the Kokanee Bend in October and November, then the Diptera dominated in December through June, and Ephemeroptera were dominant July through September. When biomass was considered, the dominant order in any month could change (Appendix B, Figures 28-38). To some extent, dominance volumetrically was a matter of chance, because if more large stoneflies or caddisflies were captured in the samples for a particular month, the balance was shifted. At the Bible Camp, mayflies were dominant volumetrically in all months but October when stoneflies were dominant, and November and September when caddisflies were dominant. The stoneflies were dominant volumetrically at Kokanee Bend, except in November, January and April when caddisflies were dominant, and June when large numbers of blackflies changed the dominant category to Other.

Table 5. Biomass (cc/m²) (Kick + Circular Samples)
Annual Mean of Monthly Means (October 1979 - September 1980)

	Bible Camp n=9 $\bar{\bar{x}}$(s.d.)	Kokanee Bend n=9 $\bar{\bar{x}}$(s.d.)	South Fork n=11 $\bar{\bar{x}}$(s.d.)
Ephemeroptera	3.9(1.2)	2.9(0.7)	1.9(0.8)
Plecoptera	2.6(1.2)	4.8(1.5)	0.7(0.4)
Trichoptera	2.5(1.0)	3.2(2.4)	0.2(0.2)
Chironomidae	1.4(0.4)	1.3(0.2)	5.9(1.7)
Other Invertebrates	1.7(0.6)	2.2(2.5)	3.6(1.3)
TOTAL	12.1(2.1)	14.4(4.5)	12.3(2.9)
Percent Composition	%	%	%
Ephemeroptera	32.2	20.1	15.4
Plecoptera	21.5	33.3	5.7
Trichoptera	20.7	22.2	1.6
Chironomidae	11.6	9.0	48.0
Other Invertebrates	14.0	15.3	29.3

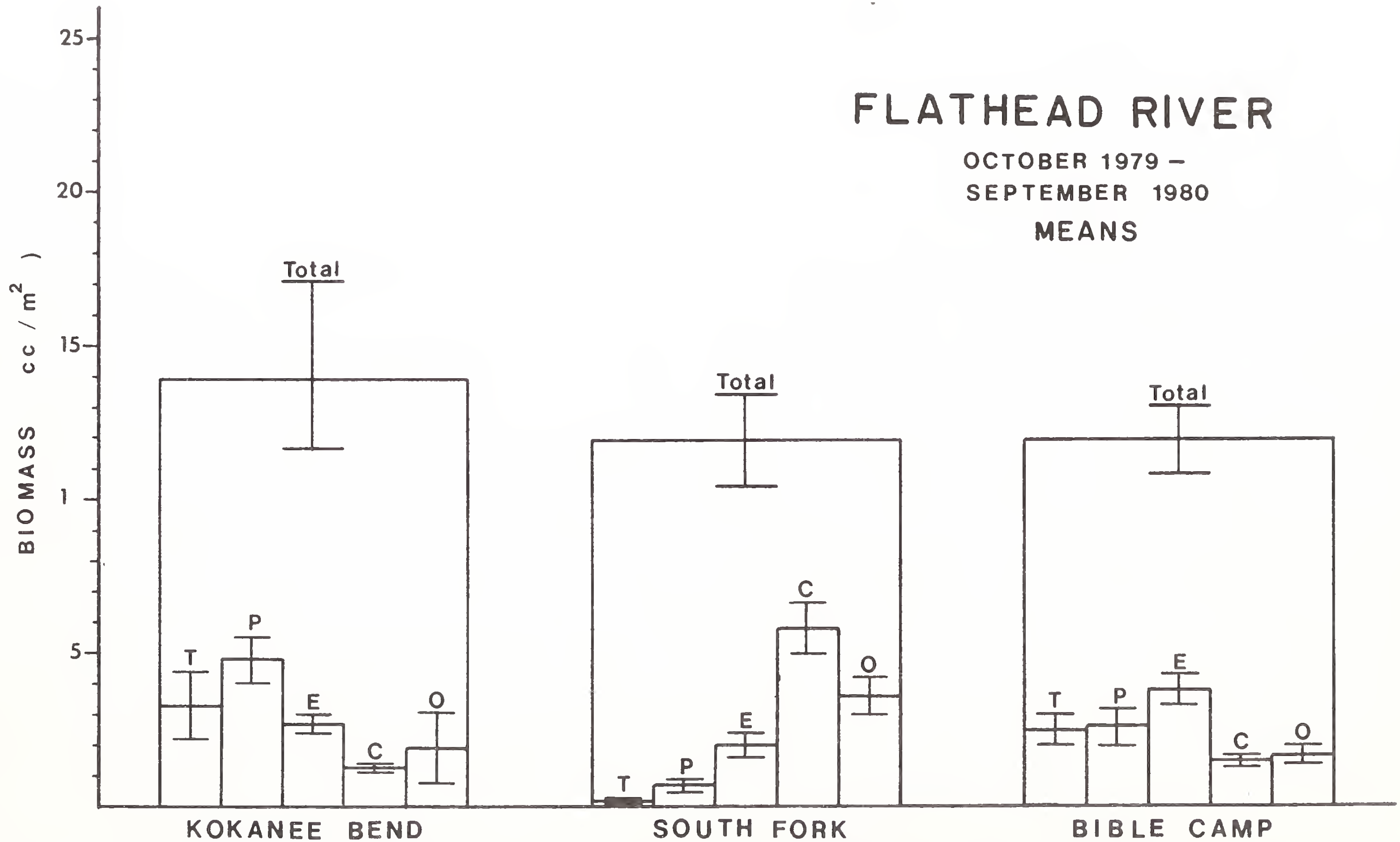


Figure 14. Biomass (cc/m²) of invertebrates; annual means of monthly means. Bars represent means; I represents standard deviations, means of total invertebrate biomass are represented by the large blocks. T = Trichoptera; P = Plecoptera; E = Ephemeroptera; C = Chironomidae; O = Other Diptera and Other Invertebrates.

Table 6. Percent of total number (no./m^2) of invertebrates represented by insect order (Kick and Circular samples combined).

	Ephemeroptera	Plecoptera	Trichoptera	Chironomidae	Other Diptera	Other Invertebrates
Bible Camp						
October	52.0	34.0	9.3	3.4	0.2	1.2
November	56.3	18.8	6.5	16.9	0.5	1.0
December	59.8	11.7	3.8	23.8	0.3	0.5
January	----	----	----	----	----	----
February	----	----	----	----	----	----
March	62.6	8.6	2.1	25.7	0.3	0.8
April	63.1	3.5	1.3	29.4	2.2	0.4
May	----	----	----	----	----	----
June	50.7	4.7	1.3	38.6	4.1	0.6
July	46.4	6.8	6.5	34.8	3.4	2.1
August	39.0	3.2	7.9	26.7	22.6	0.6
September	51.1	14.7	7.4	22.1	0.9	2.8
Kokanee Bend						
October	30.6	42.7	12.2	6.9	0.6	7.0
November	22.4	33.6	9.4	33.5	0.3	0.8
December	20.8	16.4	11.7	35.0	0.5	15.6
January	30.4	16.1	16.3	34.3	1.0	1.9
February	25.1	24.6	7.3	40.1	1.0	1.9
March	19.4	27.8	5.9	43.1	1.7	2.3
April	34.6	4.1	3.9	37.2	16.0	4.1
May	----	----	----	----	----	----
June	20.2	1.4	0.3	25.9	49.2	3.0
July	43.4	10.3	3.0	30.6	4.1	8.4
August	27.2	9.5	13.3	28.2	9.8	12.0
September	33.2	13.7	11.2	31.9	2.1	7.9

Table 6. (Continued)

	Ephemeroptera	Plecoptera	Trichoptera	Chironomidae	Other Diptera	Other Invertebrates
South Fork						
October 1979	0.2	0.7	0.01	97.7	0	2.5
November	0.7	1.3	0.05	93.5	0	4.4
December	1.0	0.7	0.006	95.3	0	3.0
January 1980	3.3	0.6	0	87.4	0	8.7
February	3.0	0.8	0.1	88.4	0.4	7.4
March	3.7	0.8	0.1	85.8	0.4	9.3
April	4.5	0.5	0.2	78.8	7.4	8.6
May	5.8	1.2	0.1	79.3	4.4	9.2
June	1.4	0.2	0.06	80.5	0.3	17.5
July	3.6	0.5	0.03	79.6	0.08	16.2
August	3.2	0.5	0.06	82.6	0.1	13.6
September	5.3	0.9	0.05	78.5	0.02	15.0

Table 7. Percent of total biomass (cc/m^2) of invertebrates represented by insect order (Kick and Circular samples combined).

	Ephemeroptera	Plecoptera	Trichoptera	Chironomidae	Other
Bible Camp					
October	25.5	31.2	25.5	6.4	11.5
November	24.3	25.7	27.8	11.1	11.1
December	30.5	26.7	17.1	11.4	14.3
January	----	----	----	----	----
February	----	----	----	----	----
March	39.7	24.4	16.0	11.5	8.4
April	43.4	20.2	13.2	11.6	11.6
May	----	----	----	----	----
June	42.1	11.4	11.4	13.2	21.9
July	35.2	14.8	22.1	18.0	9.8
August	22.2	17.6	21.3	11.1	27.8
September	26.1	16.3	29.3	14.1	14.1
Kokanee Bend					
October	16.9	41.6	26.0	7.1	8.4
November	14.0	32.3	38.9	7.4	7.4
December	16.4	38.2	26.4	10.0	9.1
January	17.4	33.0	38.3	6.1	5.2
February	17.2	41.8	21.6	11.2	8.2
March	18.1	44.9	22.0	7.9	7.1
April	23.9	26.8	29.7	10.1	9.4
May	----	----	----	----	----
June	17.6	26.0	4.9	7.8	43.6
July	30.8	30.8	12.5	11.7	14.2
August	22.7	29.9	18.6	11.3	17.5
September	26.5	35.4	16.8	11.5	9.7

Table 7. (Continued)

	Ephemeroptera	Plecoptera	Trichoptera	Chironomidae	Other
South Fork					
October	5.3	2.7	0	73.3	18.7
November	19.8	0	0	54.2	26.0
December	13.1	0.8	0	59.0	27.0
January	10.5	7.6	1.2	55.6	25.1
February	14.2	6.2	1.8	57.5	20.4
March	15.8	6.5	1.4	51.1	25.2
April	18.2	3.1	3.8	34.0	40.9
May	22.7	7.2	1.0	36.6	32.5
June	15.2	6.5	0.2	32.6	45.6
July	22.2	7.1	0.8	37.3	32.5
August	23.4	6.6	2.2	39.4	28.5
September	9.3	11.1	0.9	50.0	28.7

Life History

Temperature is an important regulator of the sequencing of insect life histories. Our data indicated changes occurred in growth rates and emergence times of some insects due to regulation. Life history studies are continuing to verify this. Our adult collections have not yet been identified and head capsule measurements have not been made to document growth rates. Lehmkuhl (1979) concluded that relatively little information was available on the effects of environmental disturbances on insect life cycles.

Many insects have strict temperature requirements, and minor alterations in temperature can have drastic effects. Life histories are often dimensioned by temperature summation criteria (Lehmkuhl 1972; Stanford 1975). Species for which the number of degree days is inadequate for larval maturation may be eliminated. Colder summer temperatures at Kokanee Bend slowed summer growth rates. The total number of degree days (graphed as mean daily temperatures summed by the month) was less in the partially regulated sections of the river from June through September due to cold water discharges from Hungry Horse Dam (Figure 15).

A number of species which were in early instars during the summer and early fall, when temperatures were warmer at the control site, obtained maximum numbers one month later at Kokanee Bend than at the control site (e.g. *Ephemerella doddsi*, *Ephemerella tibialis*, *Ephemerella flavilinea*, *Epeorus sp.*, *Paraleptophlebia heteronea*, *Classenia sabulosa*, *Isoperla fulva* *Pteronarcella badia*, *Arctopsyche grandis*, *Symphitopsyche oslari*, *Symphitopsyche cockerelli*, *Brachycentrus sp.*, and *Atherix variegata*). This was apparently due to the fact that the heat accumulation was greater during the summer and early fall months in unregulated areas of the river. Elliott (1972) found that the time between oviposition and hatching and the length of the hatching period may be greatly extended by low summer temperatures. The reverse situation appears to have occurred in species which were growing later in the fall when temperatures were warmer in the partially regulated areas. Small capniid and chloroperlid stoneflies reached their maximum abundance one month later at the Bible Camp. These observations need to be further substantiated by emergence data and head capsule measurements.

Sweeney and Vannote (1978) found that small adult aquatic insects with reduced fecundity resulted when temperatures were either warmed or cooled with respect to more optimal thermal conditions. Temperature apparently affected adult size by altering the larval growth rate and the timing and rate of adult tissue development. Monitoring adult size and fecundity of aquatic insects was suggested as a tool for assessing the impact of sublethal alteration of natural temperature patterns. Warming the seasonal cycles of a river by 2° to 3° C might eliminate species by affecting body size and fecundity.

This should be considered when planning prolonged winter discharges from Hungry Horse Dam. It is possible that sustained winter discharges

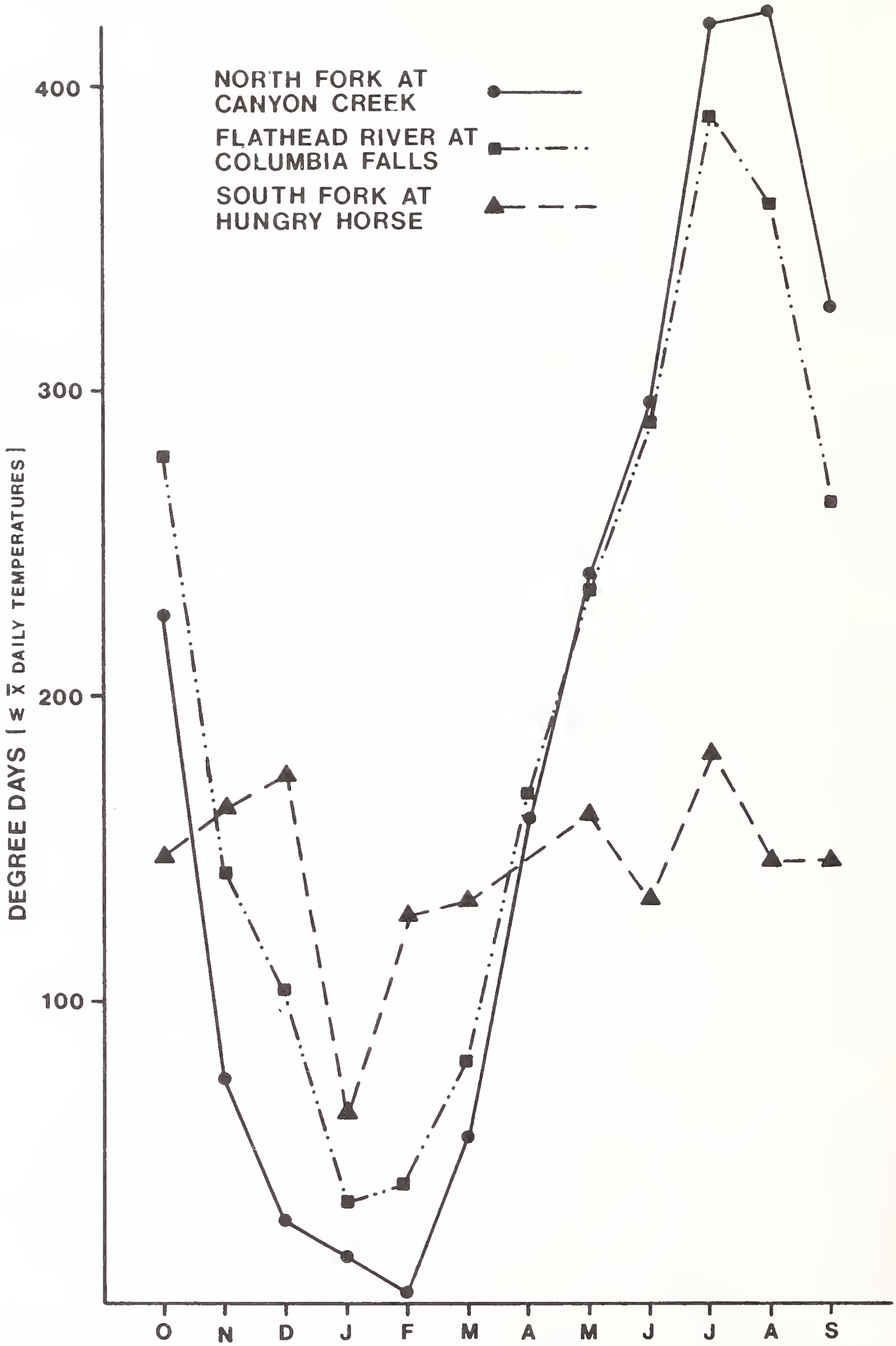


Figure 15. Degree days (mean daily temperatures) summed by the month for control (North Fork), partially regulated (Columbia Falls), and regulated (South Fork) areas of the Flathead River for the 1980 water year.

from Hungry Horse Dam could increase the winter head load in the river enough to eliminate certain species of stoneflies. During the winter of 1981, a number of species emerged earlier in the partially regulated areas of the river (starting in January). This was probably due to the combined effects of sustained winter discharge and warmer weather conditions. In a colder winter, higher winter water temperatures may induce emergence into lethally cold air or during periods when mating was impossible. The raising of river temperatures may disrupt mating behavior in some species by widening any time lag between emergence of males and females (Nebeker 1971a).

Coutant (1967) has shown that a slight temperature increase (1° C) will cause hydropsychid caddisflies to emerge two weeks earlier downstream from the Hanford (Washington) reactors than in upstream areas. In experimental situations, it has been demonstrated that exposure of aquatic insect larvae to artificially high temperatures and stable flow conditions can cause advances in the onset of adult emergence of up to five months in some species (Nebeker 1971b).

Stoneflies have been almost eliminated from the Kootenai River (Montana) since impoundment (Huston et al. 1980). This may be due in part to warmer winter temperatures. However, in the Kootenai River, winter discharges are generally continuous (no weekend shutdown) for a period of several months, which allows a greater heat accumulation. It is probable that night and weekend shutdowns at Hungry Horse Dam will prevent deleteriously high heat accumulations, although higher daily maximum temperatures than in control areas may eliminate certain species. Preliminary data indicates that stoneflies are a food source for cutthroat trout during the winter in the partially regulated area of the Flathead River. The impact of discharge changes on what appears to be an important food resource should be considered in management decisions.

RECOMMENDATIONS

Selective Withdrawal System

There is no question that a selective withdrawal system would increase species diversity and benefit invertebrate populations in the South Fork. However, due to the fact that the totally regulated section in the Flathead River is so short (8 km) and that the construction of a reregulatory dam would inundate an additional five km of the South Fork, considerations of a selective withdrawal system should be made with regard to the partially regulated area of the river rather than the South Fork.

Presently, the partially regulated area of the Flathead River supports a diverse fauna due to the ameliorative effects of waters from the free-flowing North and Middle Forks. Differences in invertebrate composition between the Bible Camp (control) and Kokanee Bend (partially regulated) sampling sites may be due as much to changes in the food regime as to

changes in temperature per se. A selective withdrawal system would introduce more plankton from the reservoir. Carbon and ATP profiles from the forebay of Hungry Horse Reservoir indicate that there are greater amounts of seston in the epilimnion than in the hypolimnion (personal communication, Jack Stanford, Director, University of Montana Biological Station). Warmer summer temperatures may further increase the growth of periphyton during the summer or early fall in the partially regulated area. The flushing effects due to changing discharges, which remove the finer organic carbon particles from the substrate and introduce coarse particulate organic matter from shoreline areas, would not be changed.

Changes in the invertebrate composition could be expected. Most mayfly species, which are unable to tolerate flow fluctuations and the loss of the fine detritus in the substrate, would not come back. Other mayfly species such as *Ephemerella inermis* and *Baetis tricaudatus* which can tolerate the flow fluctuations and feed on the increased periphyton growths would be expected to increase. These species are present in very large numbers downstream from Libby Dam, which is equipped with a selective withdrawal system. Caddisfly composition may change. *Glossosoma sp.*, which is already greatly increased in the partially regulated areas, would be expected to increase further due to increased growths of periphyton. The species of hydropsychids, which are currently more abundant in control areas, may increase due to the increased export of seston from the reservoir. It is not known how they would compete with *Arctopsyche*, which is presently the dominant species of hydropsychid at Kokanee Bend. *Arctopsyche* is not present in the Kootenai River, although it is present in the Fisher River (a tributary of the Kootenai), which has a very similar total annual heat budget. The winter stoneflies, which are the unique resource characteristic of the partially regulated Flathead River, may be adversely affected due to increased periphyton growths and altered temperatures. The factors which affect their distribution in the Flathead and Kootenai Rivers are not completely understood. They are more abundant in the partially regulated area than at the control site in the Flathead River, while they have almost been eliminated from the Kootenai River. Their elimination in the Kootenai is probably related to the fall decrease in percent saturation of oxygen, due to heavy utilization by both living and scenescent plankton in the reservoir discharges and by periphyton on the river substrate, and to the higher winter temperatures due to sustained discharges. The Flathead River is not as productive as the Kootenai (Perry, in progress), so the effects on the stoneflies may not be as marked in the Flathead. It is not fully understood how much the heavy periphyton growths in the Kootenai River are related to the warmer fall temperatures imposed by the selective withdrawal system as opposed to the generally higher nutrient load in the Kootenai system. Periphyton in the partially regulated Flathead River would still be scoured during spring runoff and light penetration would be reduced during periods when turbidity is high in the North and Middle Forks. However, marked increased in the growth of periphyton in the partially regulated Flathead River would be expected to alter insect

composition and possibly interfere with the flow of water to the hyporheic zone.

The changes which would be expected from the installation of a selective withdrawal system on Hungry Horse Dam cannot be fully predicted from the existing data base. Experimental tests which would refine our ability to make predictions and management decisions have not been done. These tests would involve rearing selected species under different temperature and food regimes in experimental streams and environmental chambers to determine their environmental requirements and is beyond the scope of the present project. Until the factors which control the distributions of invertebrates in the Flathead River have been more completely delineated, the construction of a selective withdrawal system is not presently recommended.

CONCLUSIONS

Annual means of numbers (no/m^2) and biomass (cc/m^2) data indicate that densities of zoobenthos are higher in the South Fork than at the control and partially regulated sites, but the overall biomass is not significantly different at the three sites. Species diversity is much reduced in the South Fork, but Shannon indices showed no significant differences between the control and partially regulated sites.

The faunal composition was markedly changed (consisting primarily of midges and oligochaetes) and the number of species was decreased in the South Fork, mainly due to the extreme modification of the temperature regime. Due to the addition of water from the North and Middle Forks of the Flathead River, the changes were much less marked in the partially regulated areas of the river. This can be attributed to factors such as temperature modification, the flushing and redeposition of sediments which occurs during spring runoff, the import of particulate organic carbon and drifting insects from upstream areas, etc.

However, there were compositional changes in the partially regulated portion of the river. Mayflies were far more abundant in the control area, while stoneflies and dipterans showed increased abundances in the partially regulated area. The composition of caddisflies was markedly different at the two sites due to differences in periphyton growth and particulate organic carbon particle sizes. The timing of events in the life cycle of a number of species was different at the two sites due to seasonal temperature differences.

The ameliorative effects of the North and Middle Forks are limited during seasons of lower flows from natural areas. Major changes in the discharge regime from Hungry Horse Dam during certain times of the year could substantially alter the composition of invertebrates in the main stem river. Marked increases in discharge during certain seasons (e.g. during the winter) could cause species extinctions. The partially regulated section of the Flathead River is a rather unique area, which under the current discharge regime, seems to combine advantages of both

free flowing rivers and regulation. This area currently supports a diverse fauna despite perturbations, but is not resistant to species deletion (see Pimm 1979). Until more information is available on what environmental factors are important for the maintenance of a habitat suitable for specific groups of species, caution should be exercised in altering discharge regimes.

LITERATURE CITED

Coutant, C.C. 1967. Effect of temperature on the development rate of bottom organisms, p. 11-12 in: Biological effects of thermal discharges. U.S.A.E.C. (Atomic Energy Comm.) Pac. N.W. Labs, Div. Biol. Med. Ann. Rep.

Cummins, K.W. 1966. A review of stream ecology with special emphasis on organism-substrate relationships. Spec. Publ. Pymaturing Lab. Field Biol. 4:2-51.

de March, Brigitte, G.E. 1976. Spatial and temporal patterns in macro-benthic stream diversity. J. Fish. Res. Bd. Can. 33:1261-1270.

Elliott, J.M. 1972. Effect of temperature on time of hatching in *Baetis rhodani* (Ephemeroptera: Baetidae) Oecologia 9:47-51.

Fisher, S.G. and A. LaVoy. 1972. Differences in littoral fauna due to fluctuating water levels below a hydroelectric dam. J. Fish. Res. Bd. Can. 29:1472-1476.

Gauch, H.G., Jr. 1977. ORDIFLEX a flexible computer program for four ordination techniques:weighted averages, polar ordination, principal components analysis, and recriprocal averaging. Release B. Cornell Ecology Programs Series. Cornell Univ. Ithaca, NY 180 pp.

Hauer, F.R. 1980. Ecological studies of Trichoptera in the Flathead River, Montana. PhD. Dissertation, N. Texas State Univ., Denton, Texas.

Henricson, J. and K. Müller. 1979. Stream regulation in Sweden with some examples from central Europe. pp. 183-199 in: Ward, J.V. and J.A. Stanford (eds.). The Ecology of Regulated Streams. Plenum Press, NY.

Hill, M.O. 1979. DECORANA - A FORTRAN program for detrended correspondence analysis and reciprocal averaging. Cornell Ecology Programs Series. Cornell Univ., Ithaca, NY. 52 pp.

Hilsenhoff, W.L. 1971. Changes in the downstream insect and amphipod fauna caused by an impoundment with a hypolimnial drain. Ann. Entomol. Soc. Amer. 64:743-746.

Hoffman, E.C. and R.V. Kilambi. 1971. Environmental changes produced by cold water outlets from three Arkansas reservoirs. Water Resource Research Center Publ. No. 5, Univ. Arkansas, Fayetteville, Ark.

Hulbert, S.H. 1971. The nonconcept of species diversity: a critique and alternative parameters. Ecology 52:577-586.

Lehmkuhl, D.M. 1972. Change in thermal regime as a cause of reduction of benthic fauna downstream of a reservoir. J. Fish. Res. Bd. Can. 29:1329-1332.

Lehmkuhl, D.M. 1979. Environmental disturbance and life histories: principles and examples. J. Fish. Res. Bd. Can. 36:329-334.

Margalef, D.R. 1957. Information theory in ecology. Gen. Syst. 3:36-71.

May, F., S. Appert and J. Huston. 1980. Annual Progress Report, Kootenai River Investigations. Mt. Dept. of Fish, Wildl. Parks. 26 pp.

Minshall, G. Wayne and J.N. Minshall. 1977. Macrodistribution of benthic invertebrates in a Rocky Mountain (U.S.A.) stream. Hydrobiologia 55:231-249.

Moore, P.D. 1975. Changes in species diversity. Nature 254:104-105.

Nebeker, A.V. 1971a. Effects of temperature at different altitudes on the emergence of aquatic insects from a single stream. J. Kansas Entomol. Soc. 44(1):26-35.

Nebeker, A.V. 1971b. Effect of high winter water temperatures on adult emergence of aquatic insects. Water Res. 5:777-783.

Pearson, Wm. D., R.H. Kramer and the late D.R. Franklin. 1968. Macroinvertebrates in the Green River below Flaming Gorge Dam, 1964-65 and 1967. Proc. Utah Acad. Sci., Arts Lett. 45(1):148-167.

Perry, S.A. (In progress). Comparative ecology of benthic communities in free-flowing and regulated areas of the Flathead and Kootenai River, Montana. PhD Dissertation. North Texas State Univ., Denton, Texas..

Pimm, S.L. 1979. Complexity and stability: another look at MacArthur's original hypothesis. Oikos 33:351-357.

Spence, J.A. and H.B.N. Hynes. 1971. Differences in benthos upstream and downstream of an impoundment. J. Fish. Res. Bd. Can. 28:35-43.

Stanford, J.A. 1975. Ecological studies of Plecoptera in the Upper Flathead Rivers, Montana. PhD. Dissertation, Univ. of Utah. Salt Lake City, 241 pp.

Stanford, J.A. and A.R. Gaufin. 1974. Hyporheic communities of two Montana Rivers. Science 185:700-702.

Sweeney, B.W. and R.L. Vannote. 1978. Size variation and the distributions of hemimetabolous aquatic insects: two thermal equilibrium hypotheses. Science 200:444-446.

Ward, James V. 1974. A temperature stressed stream ecosystem below a hypolimnial release mountain reservoir. Arch. Hydrobiol. 74:247-275.

Ward, James V. 1976. Effects of thermal constancy and seasonal temperature displacement on community structure of stream macroinvertebrates. In: Thermal Ecology II, G.W. Esch and R.W. McFarlane (eds.), ERDA Symp. Series (CONF-750425), pp. 302-307.

Ward, J.V. and J.A. Stanford (eds.). 1979. The Ecology of Regulated Streams. Plenum Press. NY 398 pp.

Williams, D.D. 1980. Some relationships between stream benthos and substrate heterogeneity. Limnol. Oceonogr. 25(1):166-172.

Young, W.D., D.H. Kent and B.G. Whiteside. 1976. The influence of a deep storage reservoir on the species diversity of benthic macroinvertebrate communities of the Guadalupe River, Texas. Tex. J. Scie. 27:213-224.

APPENDIX A

Figures 16 - 27

Mean number of invertebrates per square meter, October, 1979 through September, 1980.

E = Ephemeroptera

P = Plecoptera

T = Trichoptera

Ch = Chironomidae

OD = Other Diptera

OI = Other Invertebrates

Bars represent monthly means (kick and circular samples combined); I represents standard deviations.

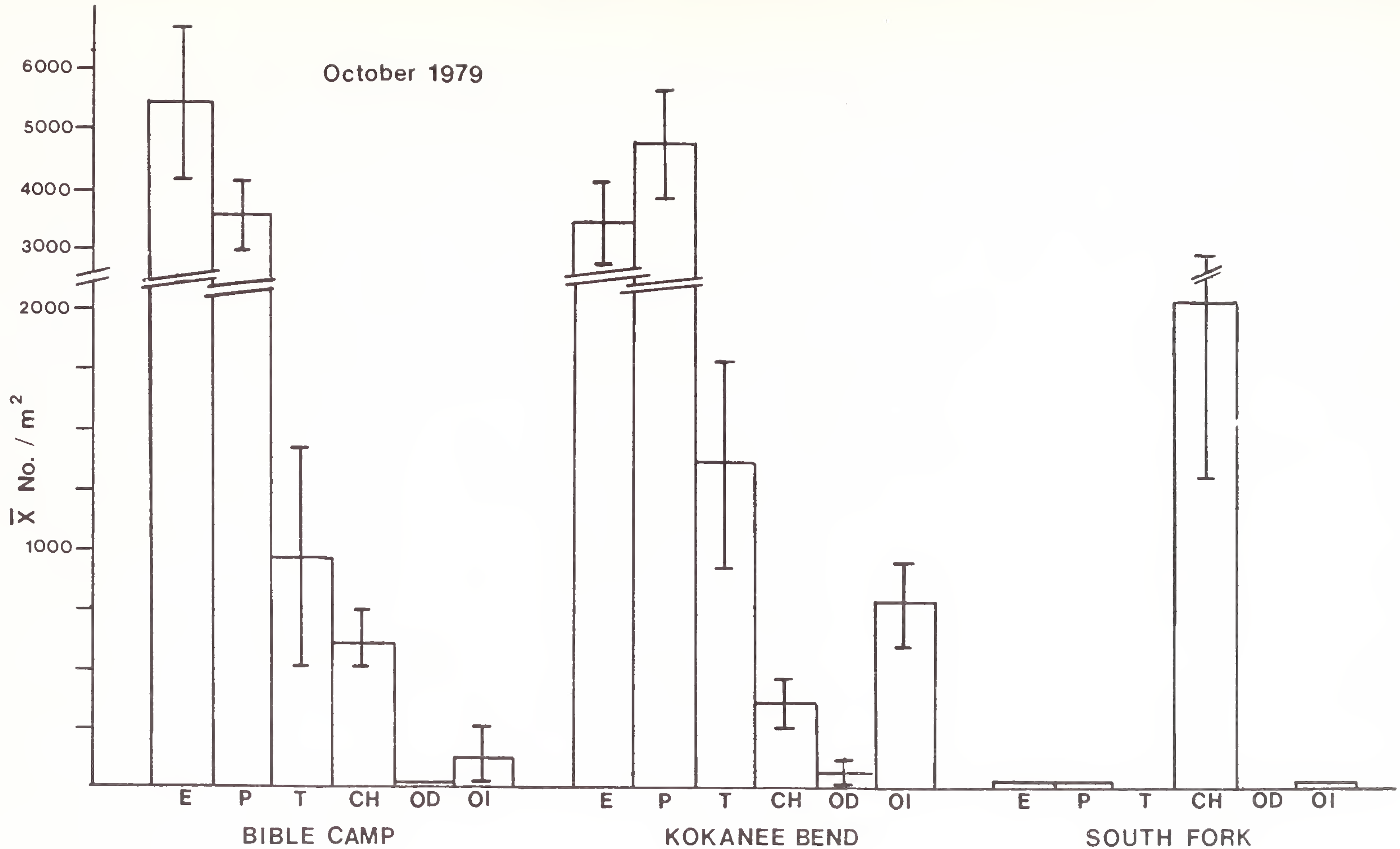
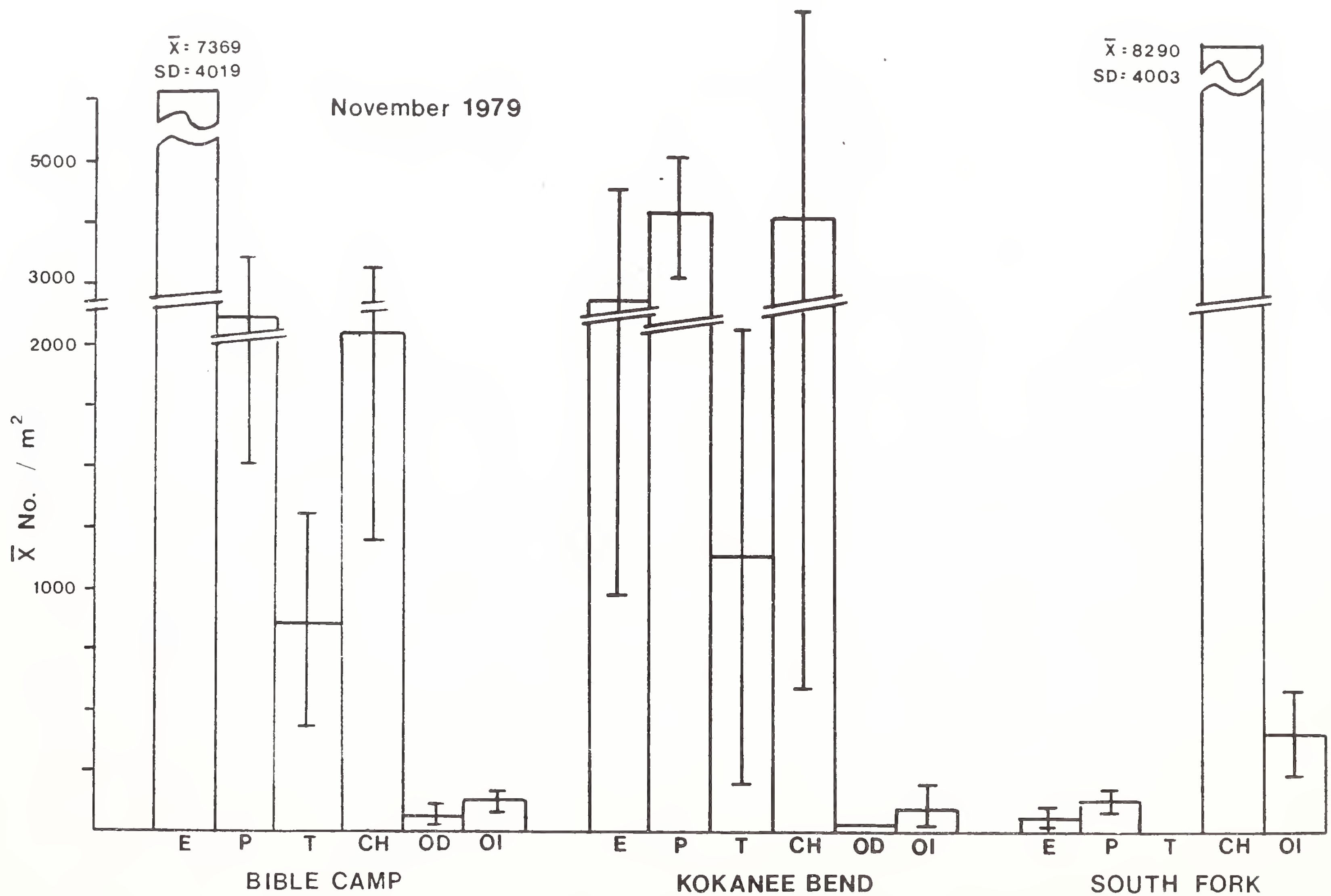

October 1979
6000
5000
4000
3000
2000
1000
$\overline{X}$ No. / m^2
E P T CH OD OI
BIBLE CAMP
E P T CH OD OI
KOKANEE BEND
E P T CH OD OI
SOUTH FORK

Figure 16.



November 1979
$\bar{X}$: 7369
SD: 4019
$\bar{X}$: 8290
SD: 4003
5000
3000
2000
1000
$\bar{X}$ No. / m^2
E P T CH OD OI
BIBLE CAMP
E P T CH OD OI
KOKANEE BEND
E P T CH OI
SOUTH FORK

Figure 17

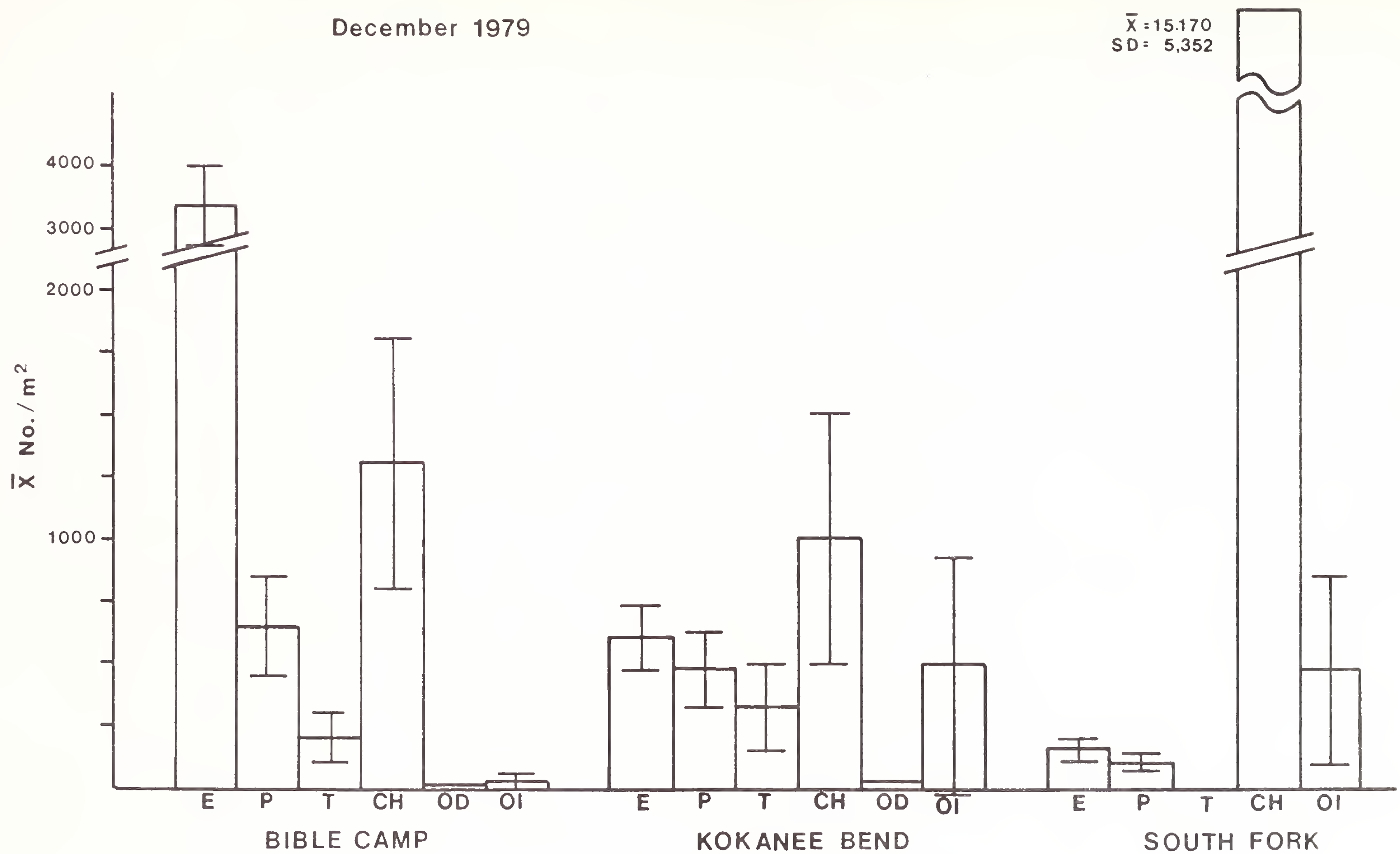

December 1979
$\bar{X}$ = 15.170
SD = 5,352
4000
3000
2000
1000
$\bar{X}$ No. / m²
E
P
T
CH
OD
OI
BIBLE CAMP
E
P
T
CH
OD
OI
KOKANEE BEND
E
P
T
CH
OI
SOUTH FORK

Figure 18

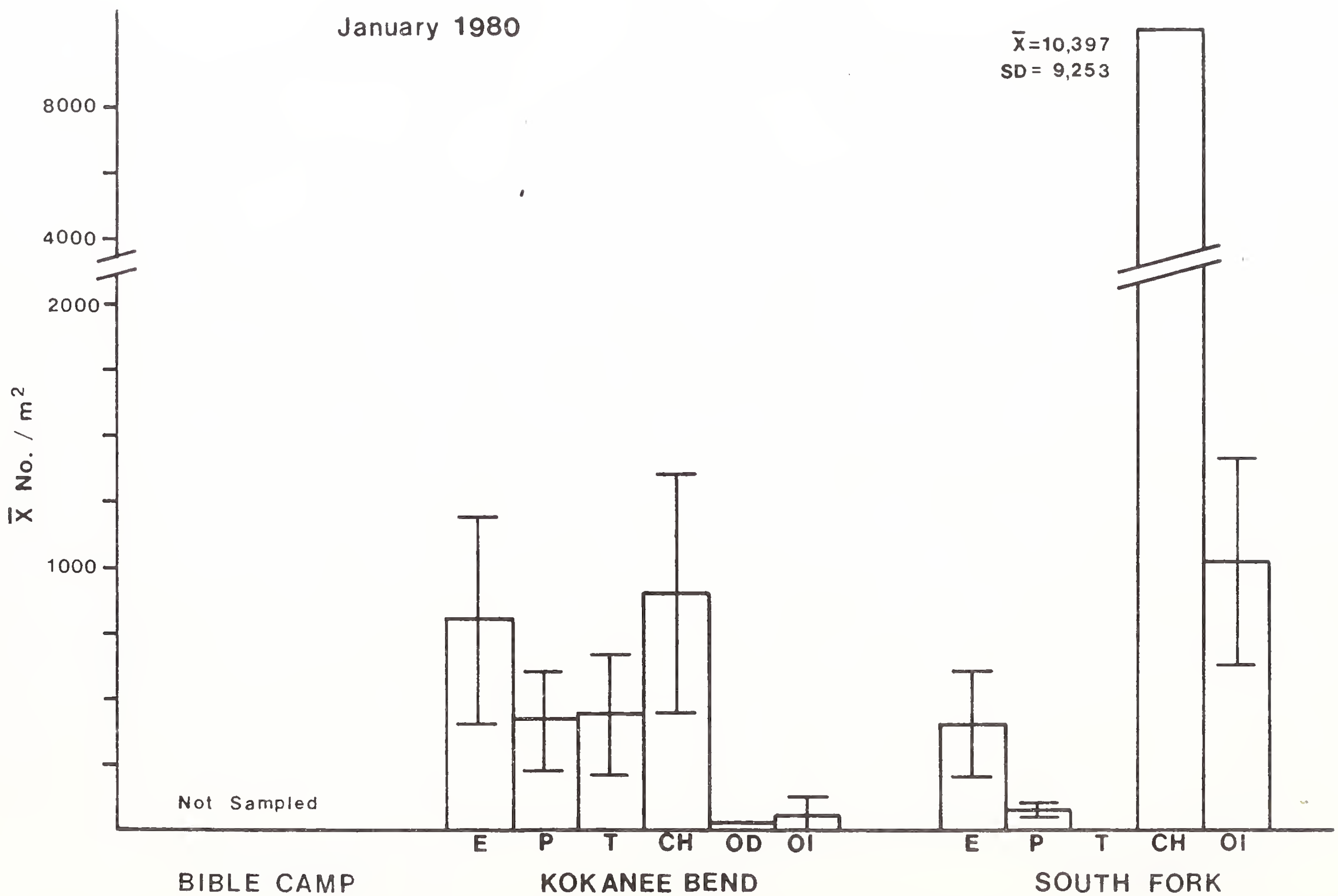

January 1980
$\bar{X}$ No. / m^2
8000
4000
2000
1000
Not Sampled
$\bar{X}$=10,397
SD = 9,253
E P T CH OD OI
E P T CH OI
BIBLE CAMP
KOKANEE BEND
SOUTH FORK

Figure 19

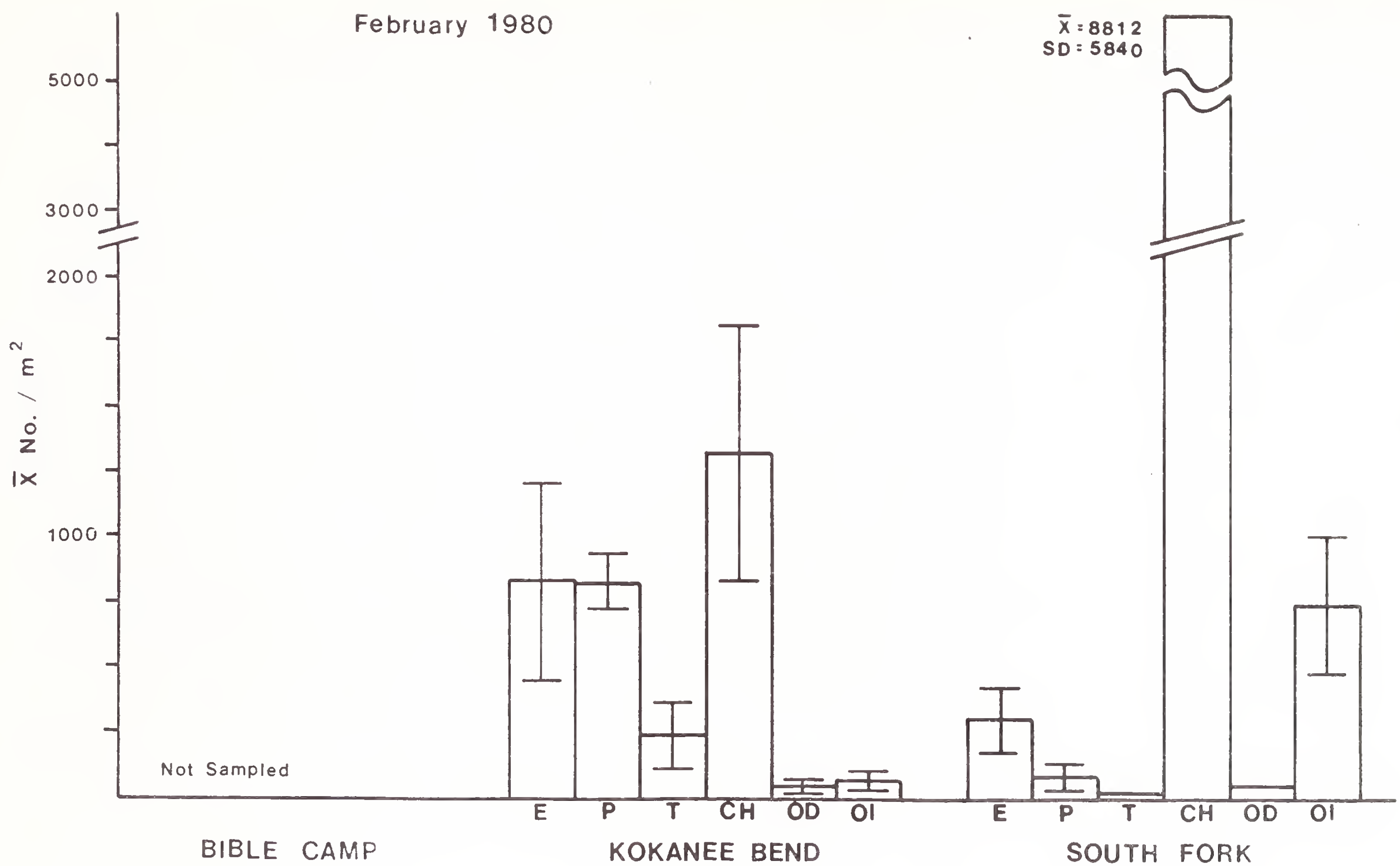

February 1980
X̄ = 8812
SD = 5840
5000
3000
2000
1000
$\bar{X}$ No. / m^2
Not Sampled
E
P
T
CH
OD
OI
E
P
T
CH
OD
OI
BIBLE CAMP
KOKANEE BEND
SOUTH FORK

Figure 20

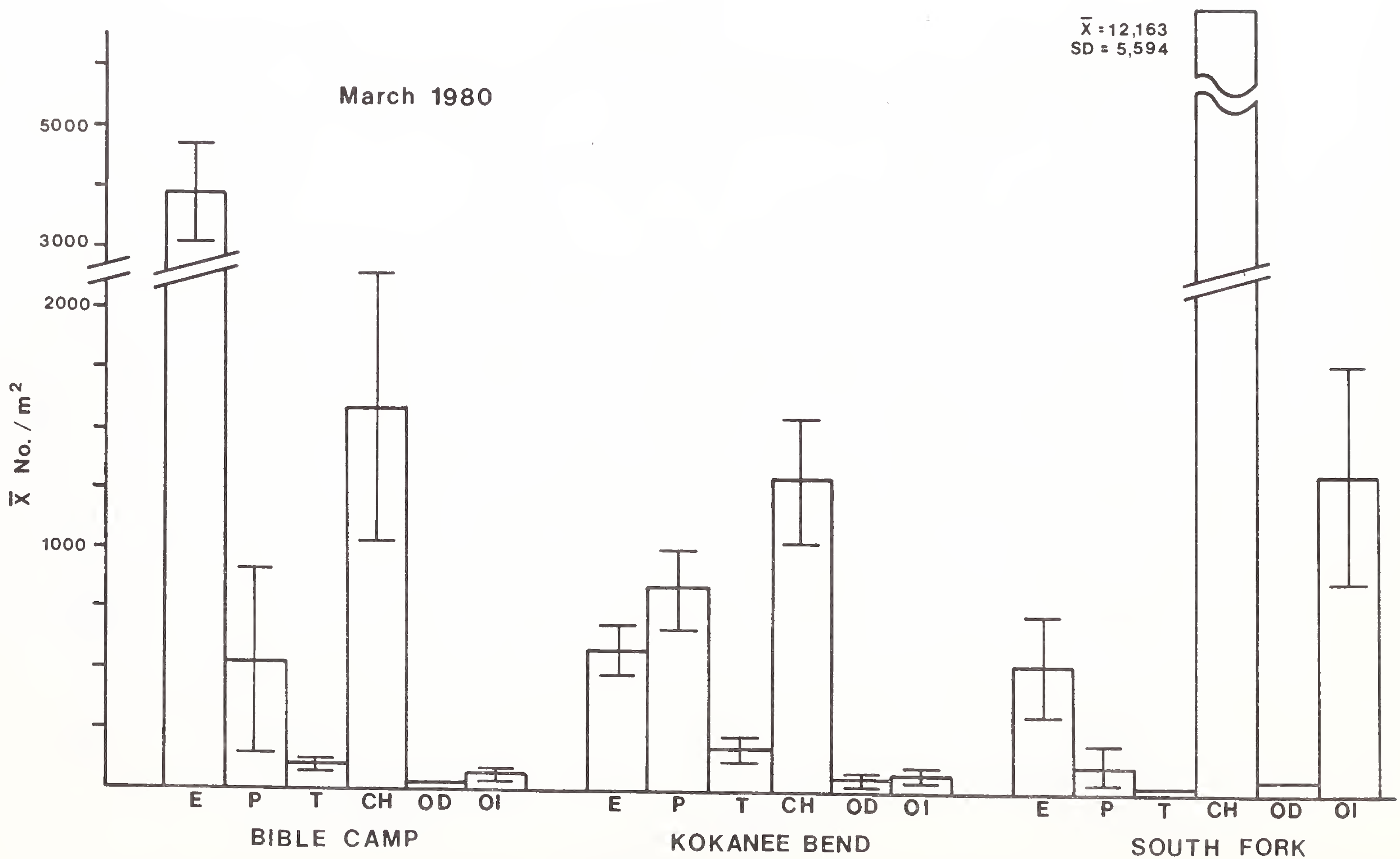

March 1980
X̄ No. / m²
5000
3000
2000
1000
E
P
T
CH
OD
OI
BIBLE CAMP
KOKANEE BEND
SOUTH FORK
X̄ = 12,163
SD = 5,594

Figure 21

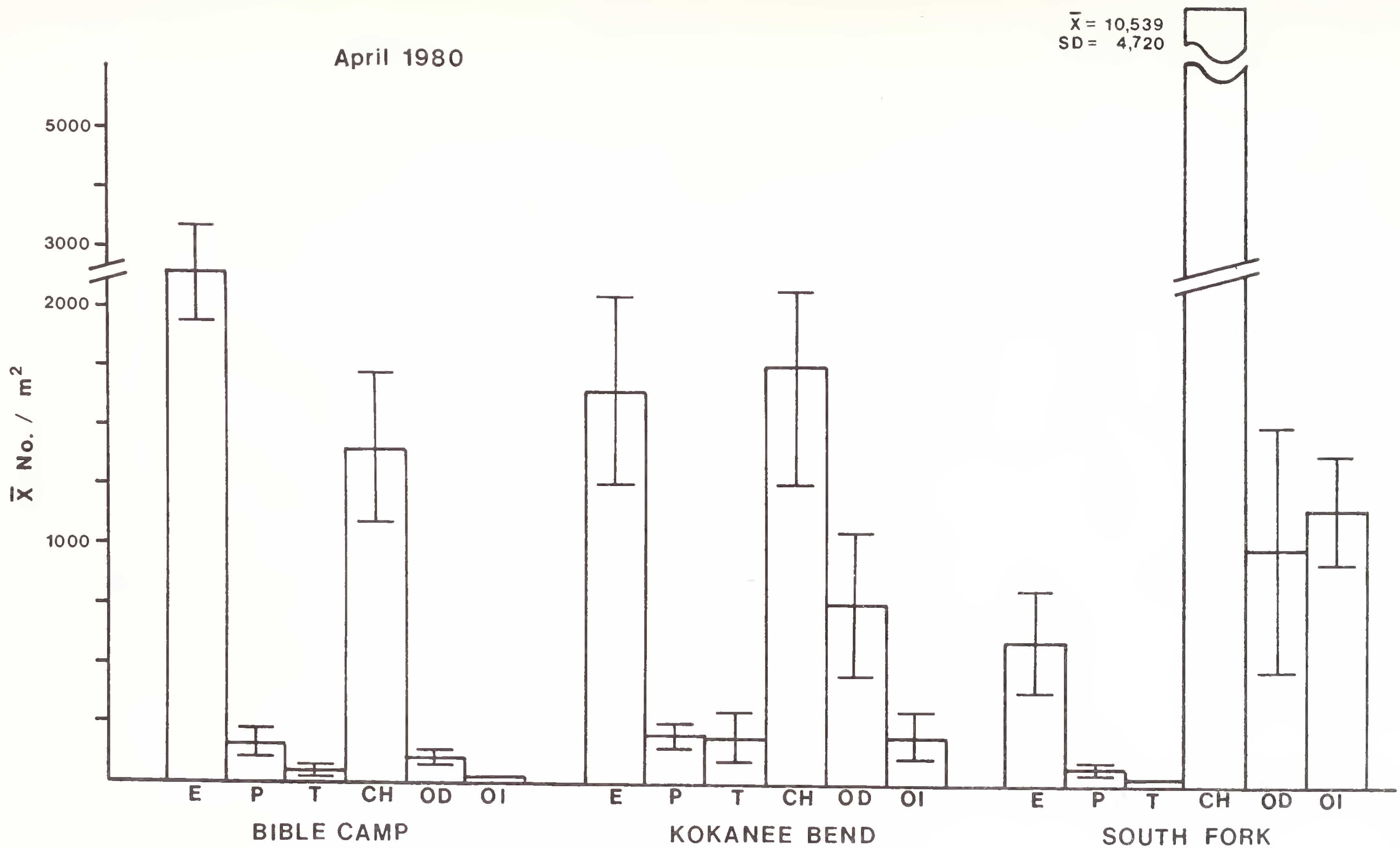
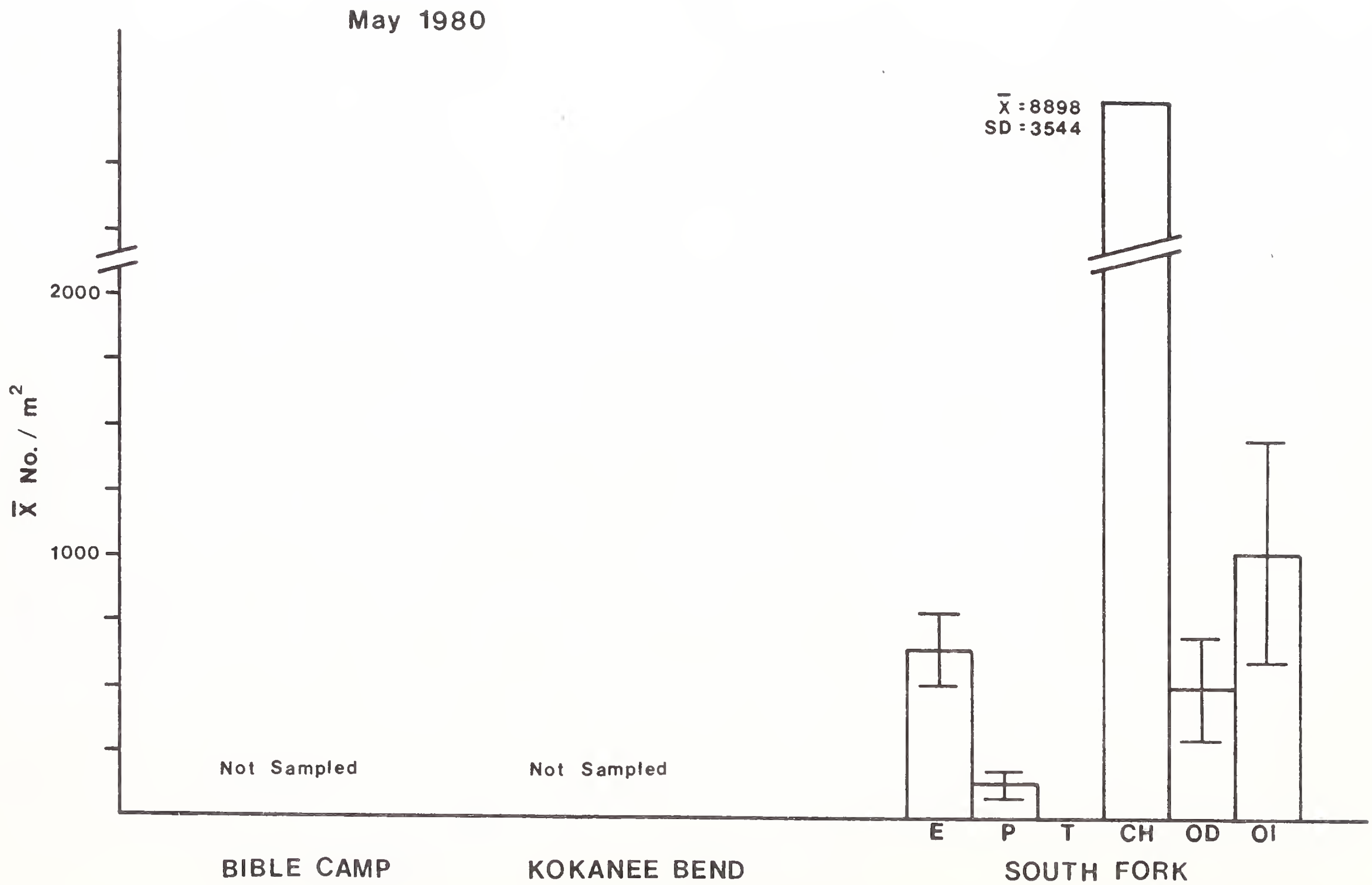

April 1980
$\bar{X}$ = 10,539
SD = 4,720
5000
3000
2000
1000
$\bar{X}$ No. / m^2
E P T CH OD OI
BIBLE CAMP
E P T CH OD OI
KOKANEE BEND
E P T CH OD OI
SOUTH FORK

Figure 22



May 1980
$\bar{X}$ No. / m^2
2000
1000
$\bar{X}$ = 8898
SD = 3544
Not Sampled
Not Sampled
E
P
T
CH
OD
OI
BIBLE CAMP
KOKANEE BEND
SOUTH FORK

Figure 23

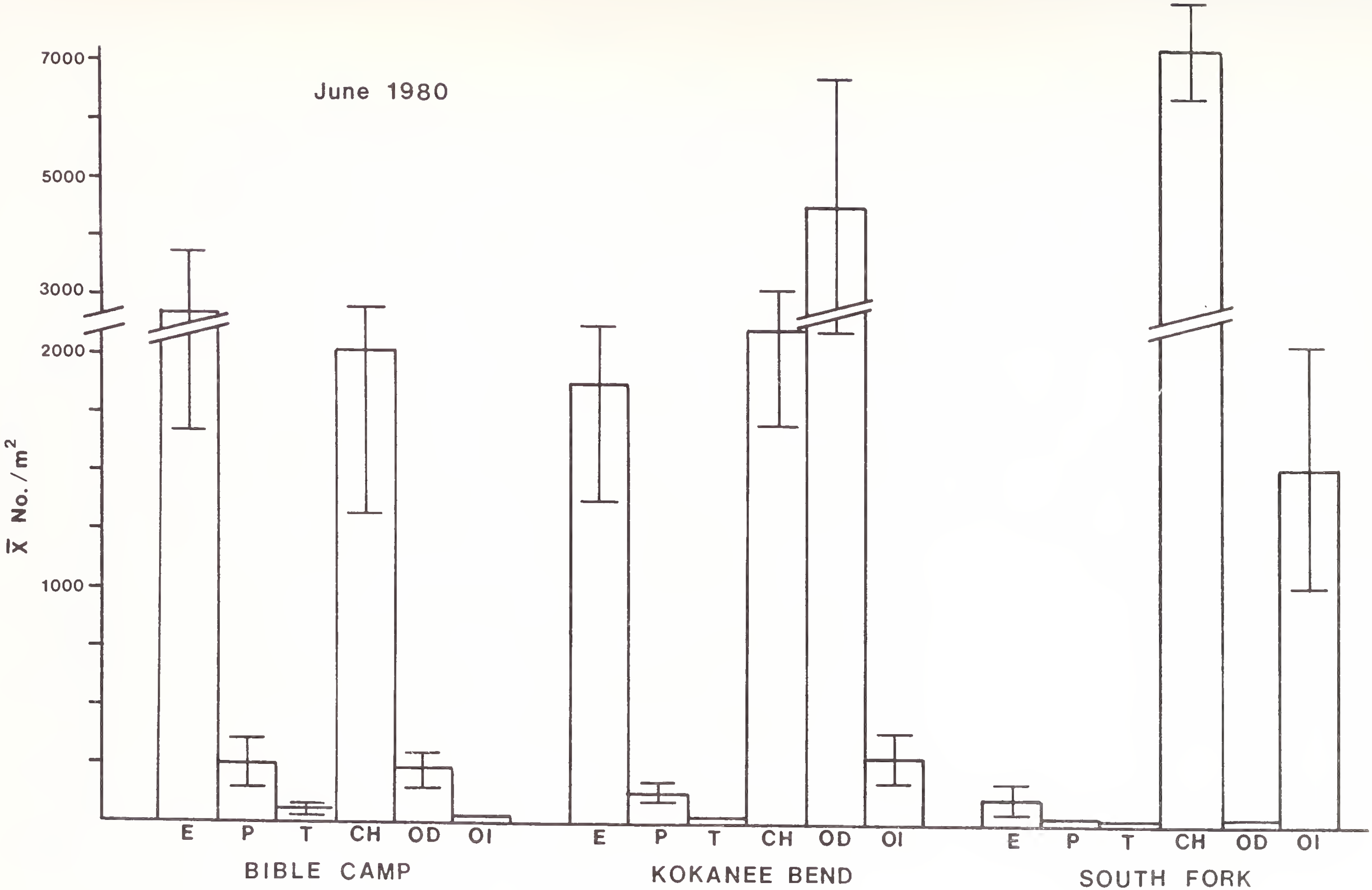

June 1980
$\overline{X}$ No./m^2
7000
5000
3000
2000
1000
E P T CH OD OI
BIBLE CAMP
E P T CH OD OI
KOKANEE BEND
E P T CH OD OI
SOUTH FORK

Figure 24

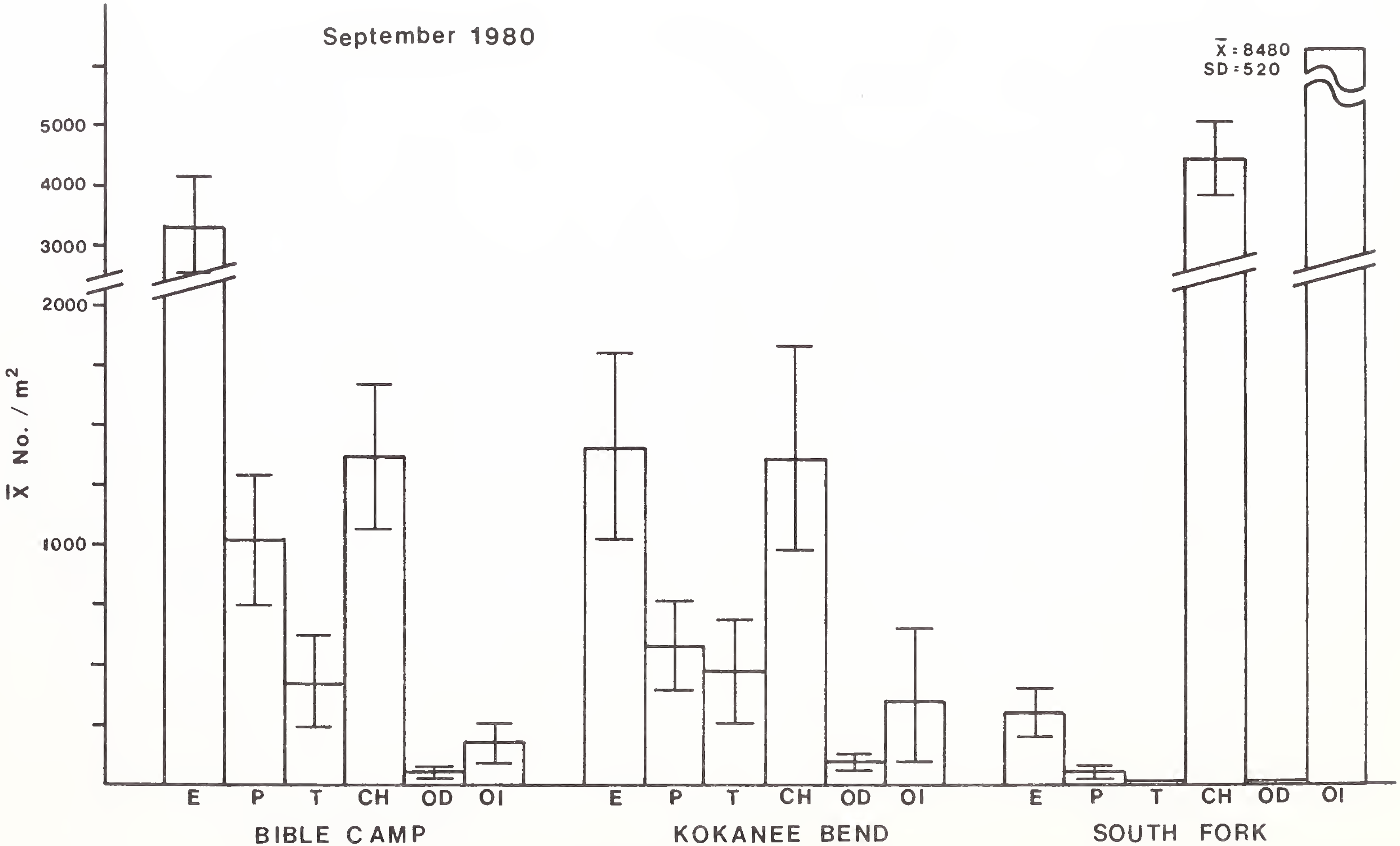

September 1980
$\bar{X}$ No. / m^2
5000
4000
3000
2000
1000
$\bar{X}$ = 8480
SD = 520
E P T CH OD OI
BIBLE CAMP
E P T CH OD OI
KOKANEE BEND
E P T CH OD OI
SOUTH FORK

Figure 27

APPENDIX B

Figures 28 - 38

Biomass (cc/m^2) of invertebrates as measured by volume displacement.

T = Trichoptera

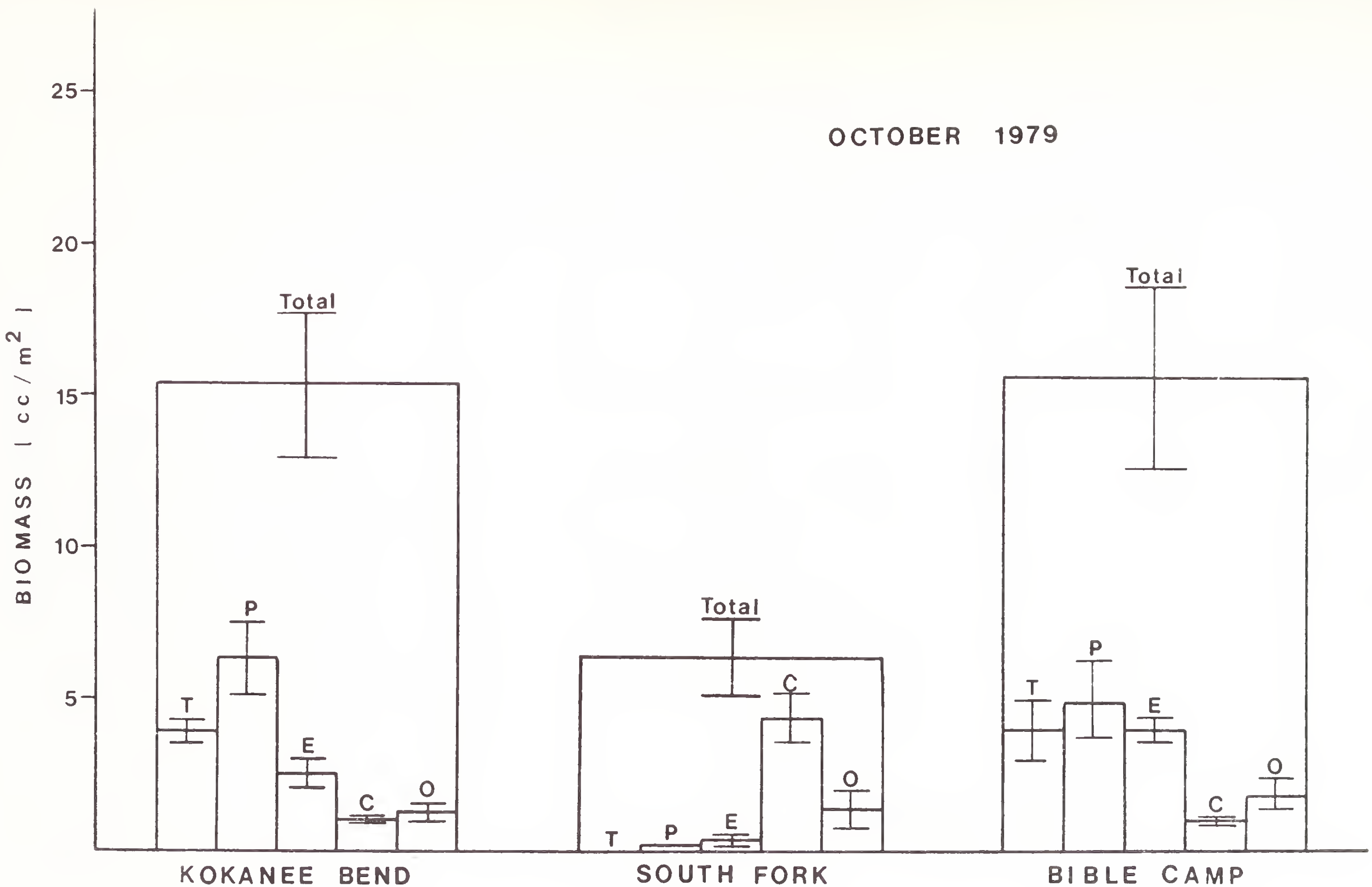
P = Plecoptera

E = Ephemeroptera

C = Chironomidae

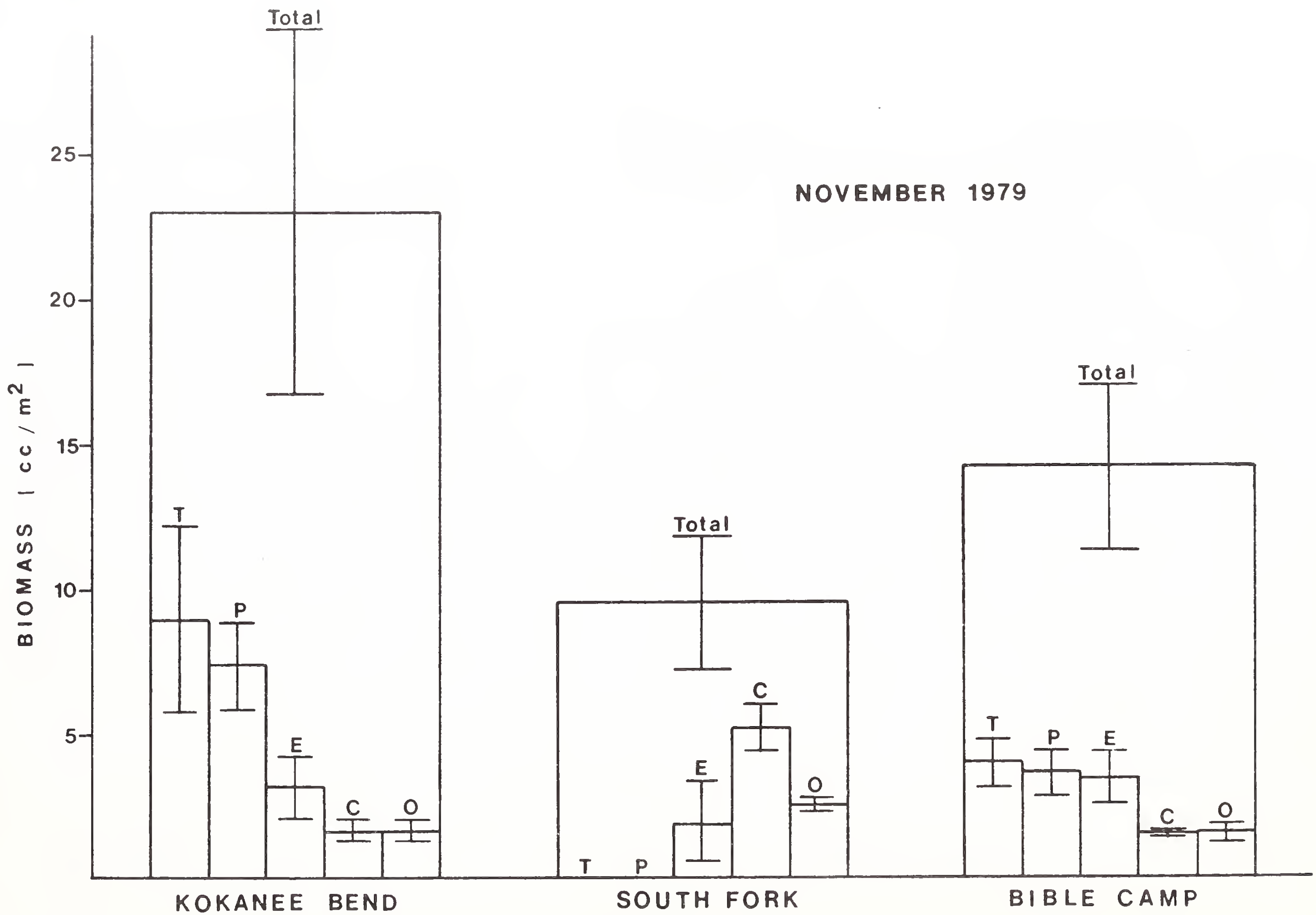
O = Other Diptera and Other Invertebrates

Bars represents monthly means (kick and circular samples combined); I represents standard deviations.



OCTOBER 1979
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 28



NOVEMBER 1979
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
Total
T
P
E
C
O
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 29

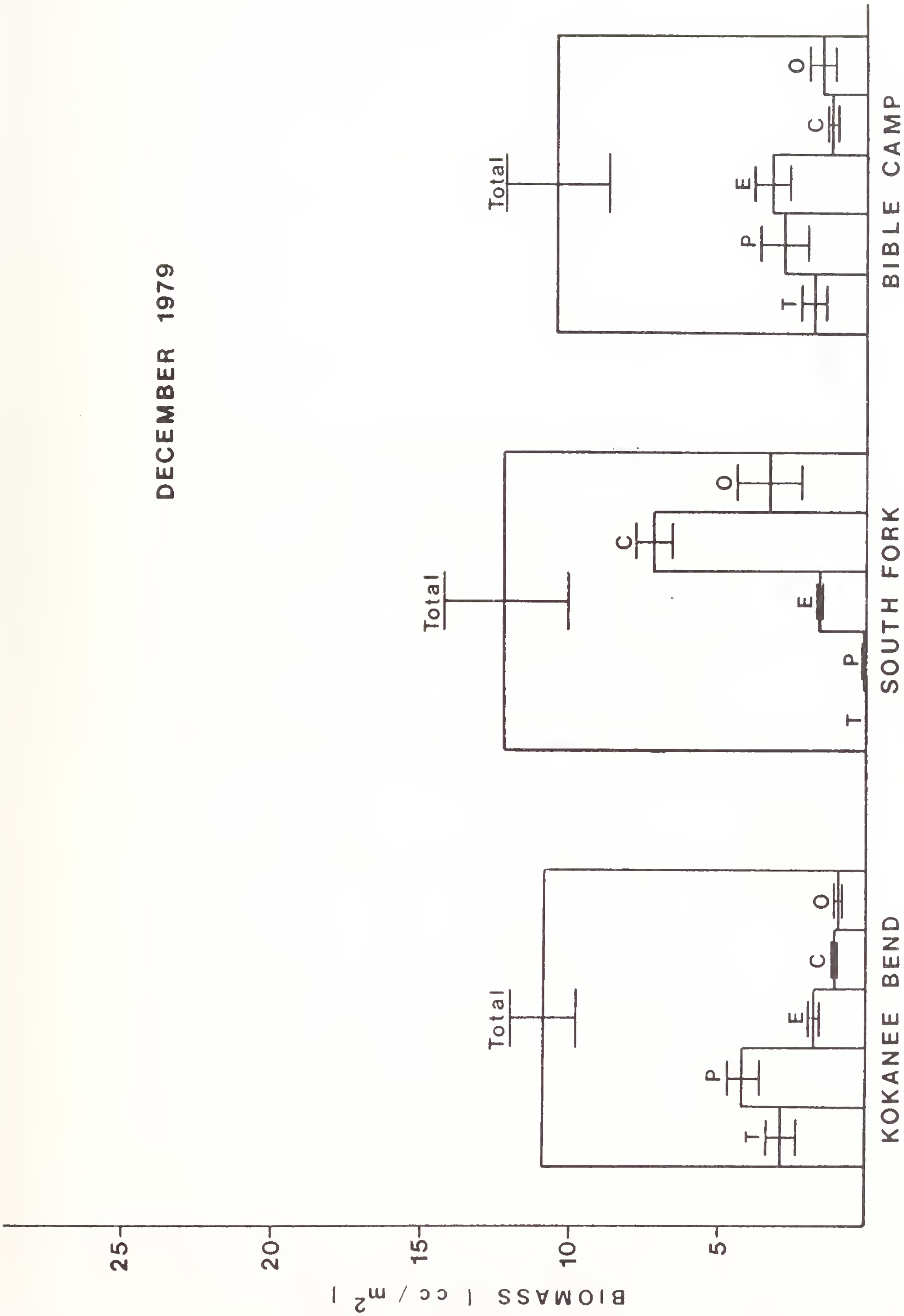
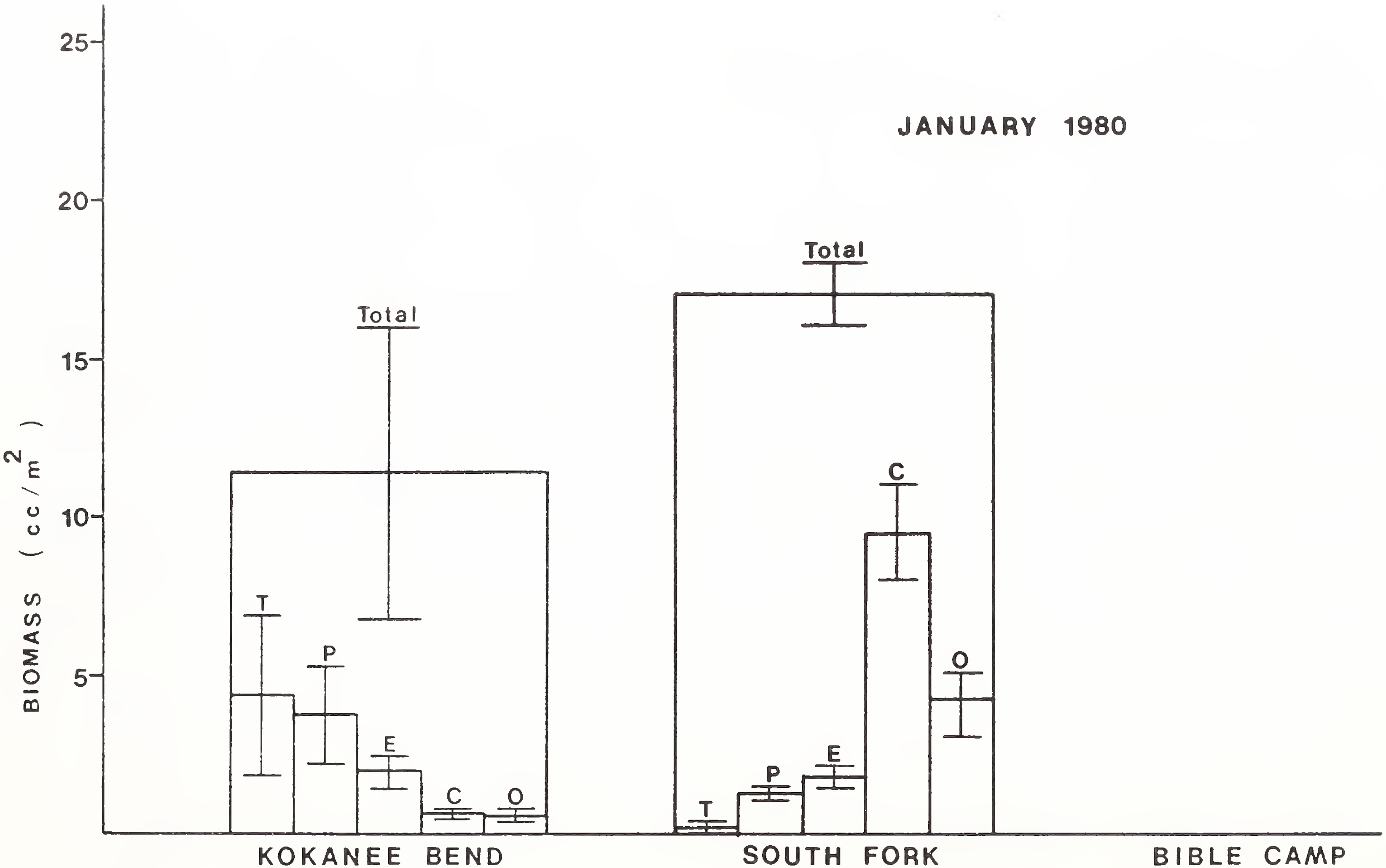

DECEMBER 1979
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 30



JANUARY 1980
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 31

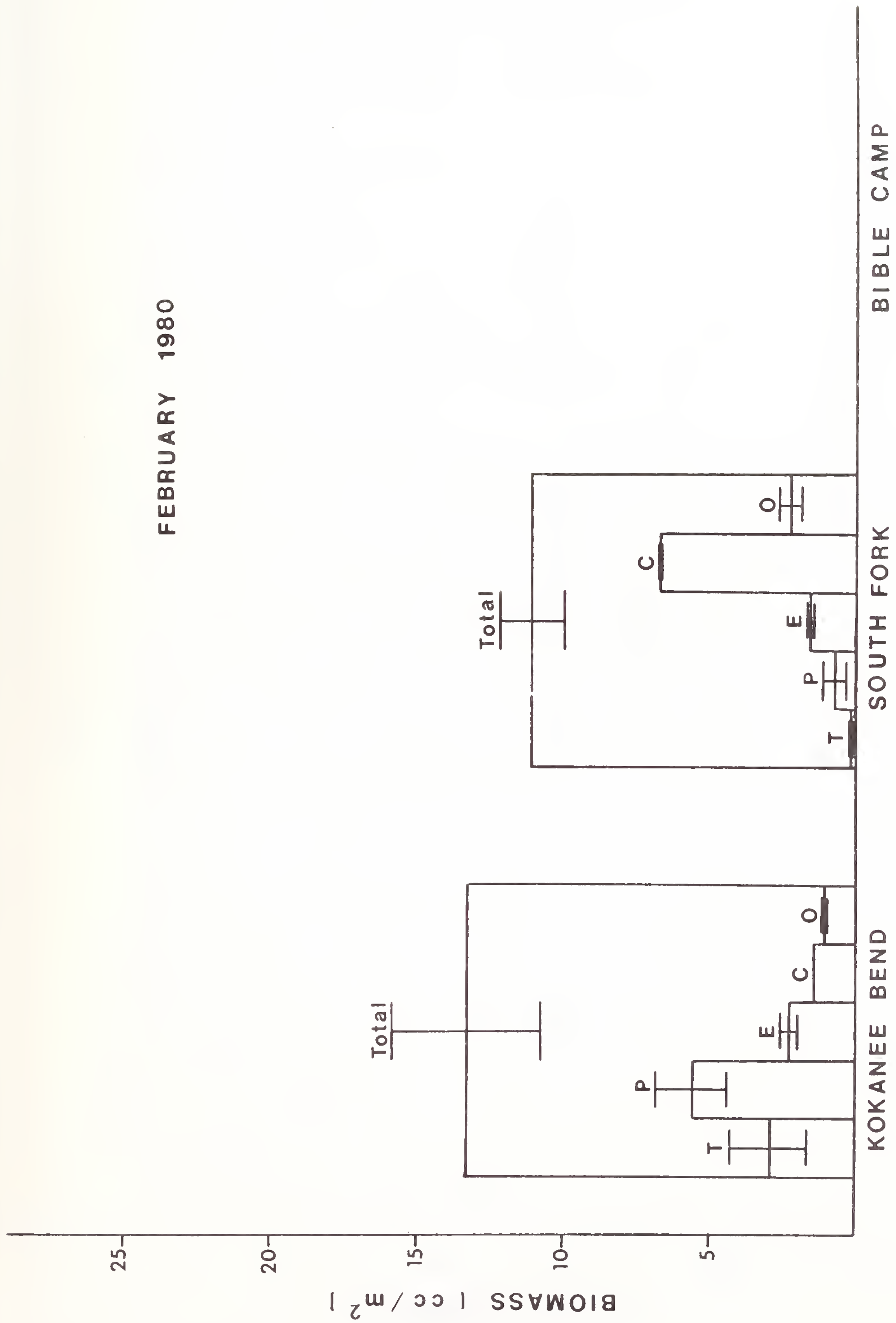
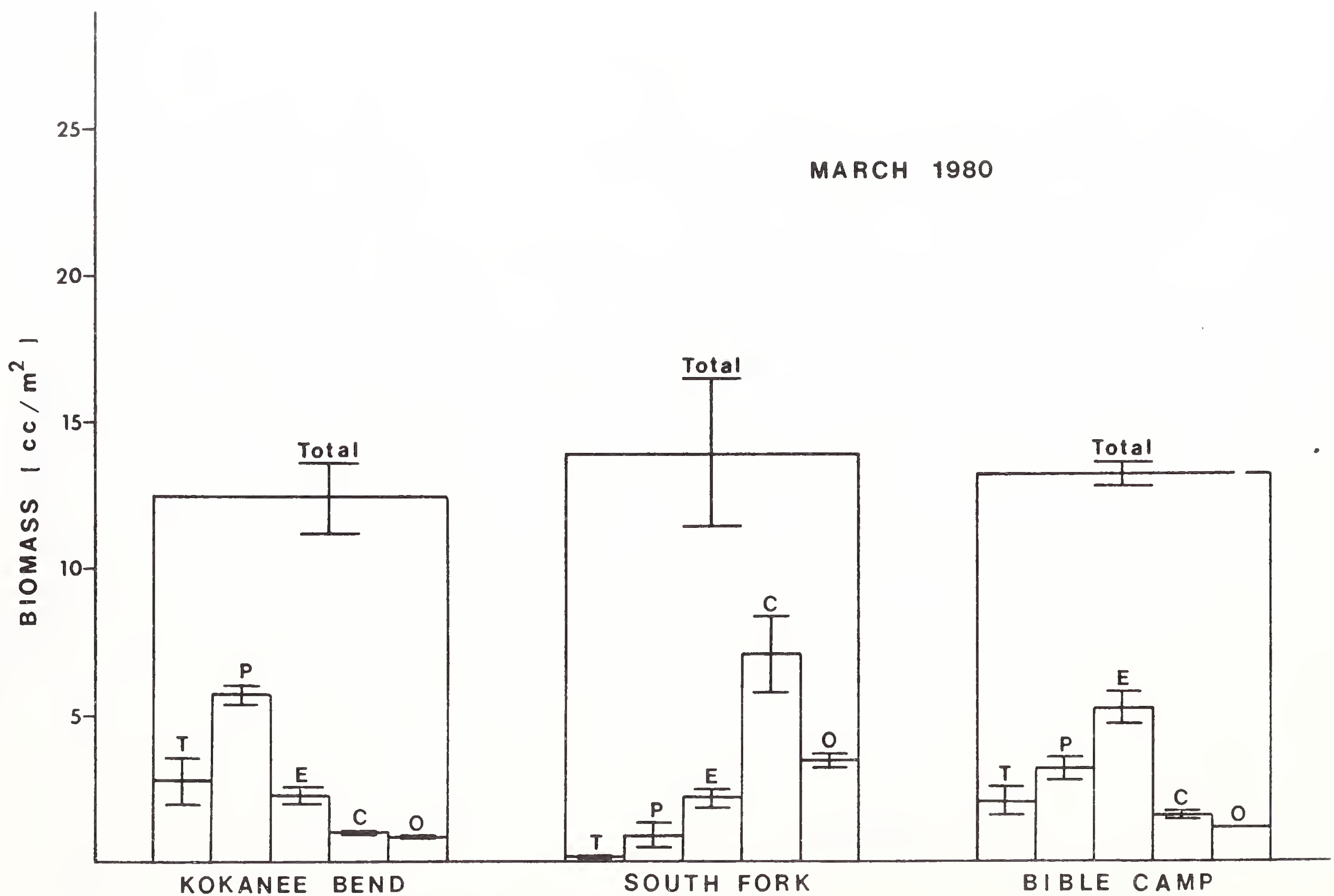

FEBRUARY 1980
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 32


MARCH 1980
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP
Figure 33

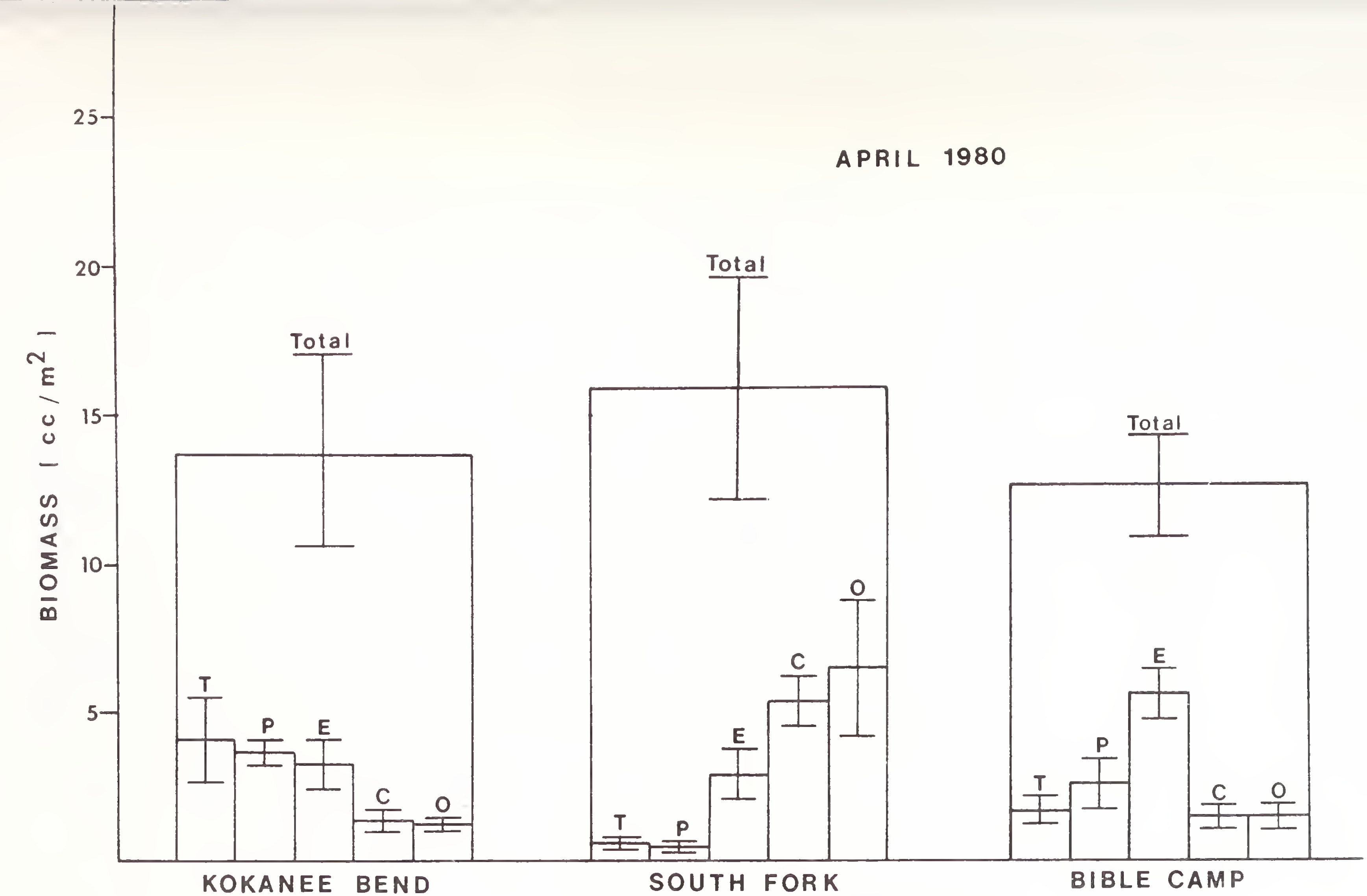

APRIL 1980
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
Total
T
P
E
C
O
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 34

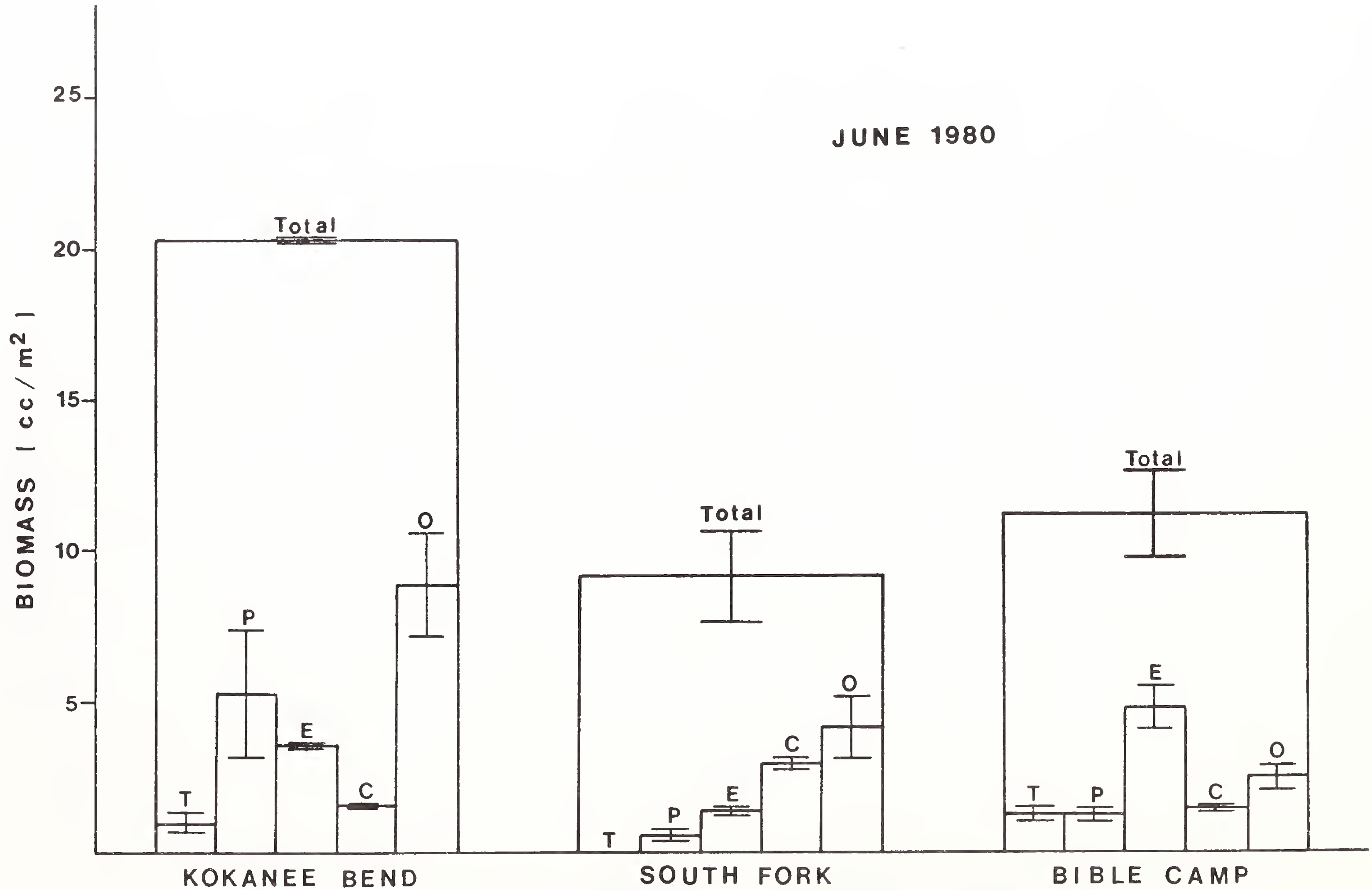

JUNE 1980
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 35

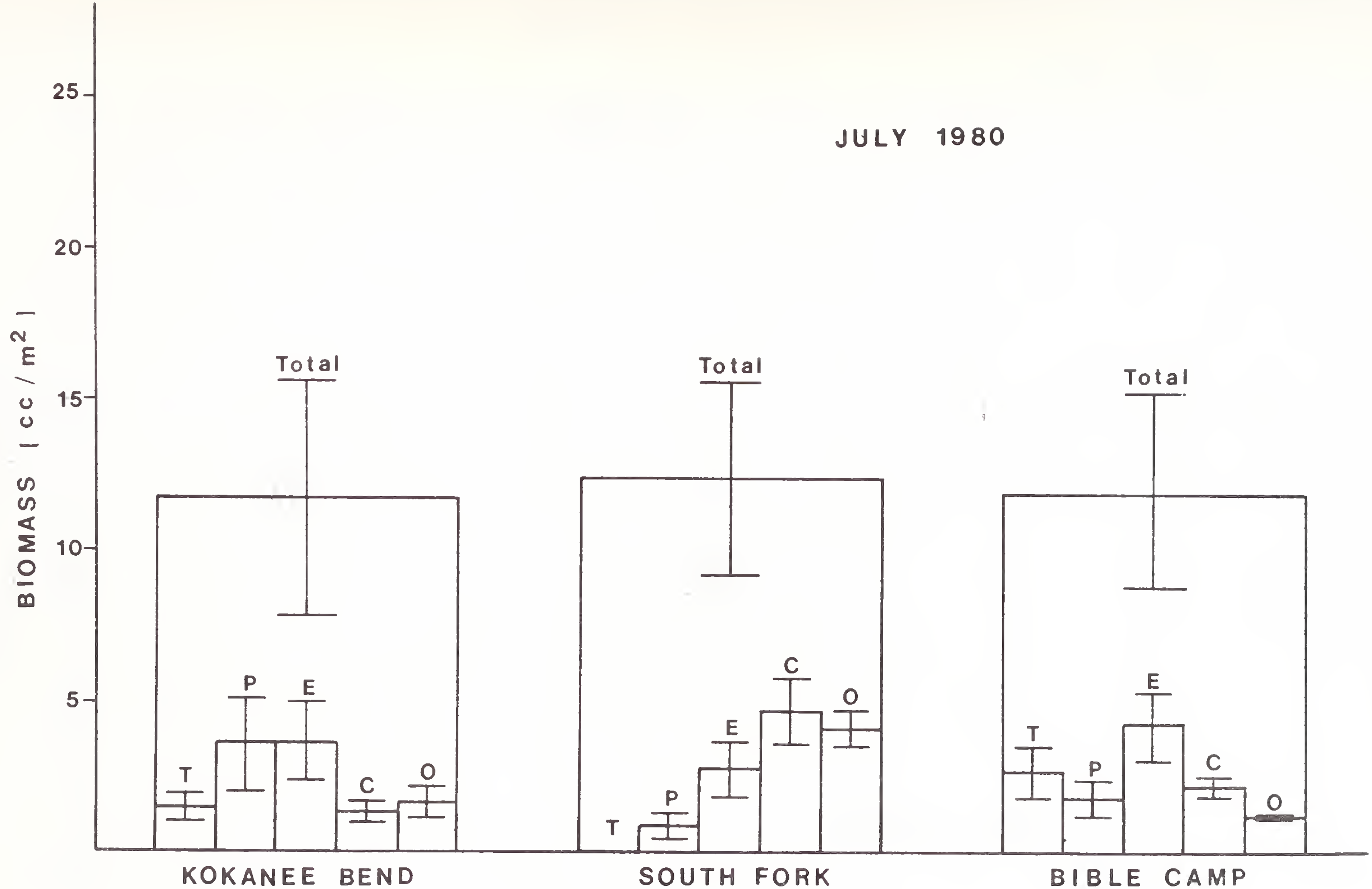

JULY 1980
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 36

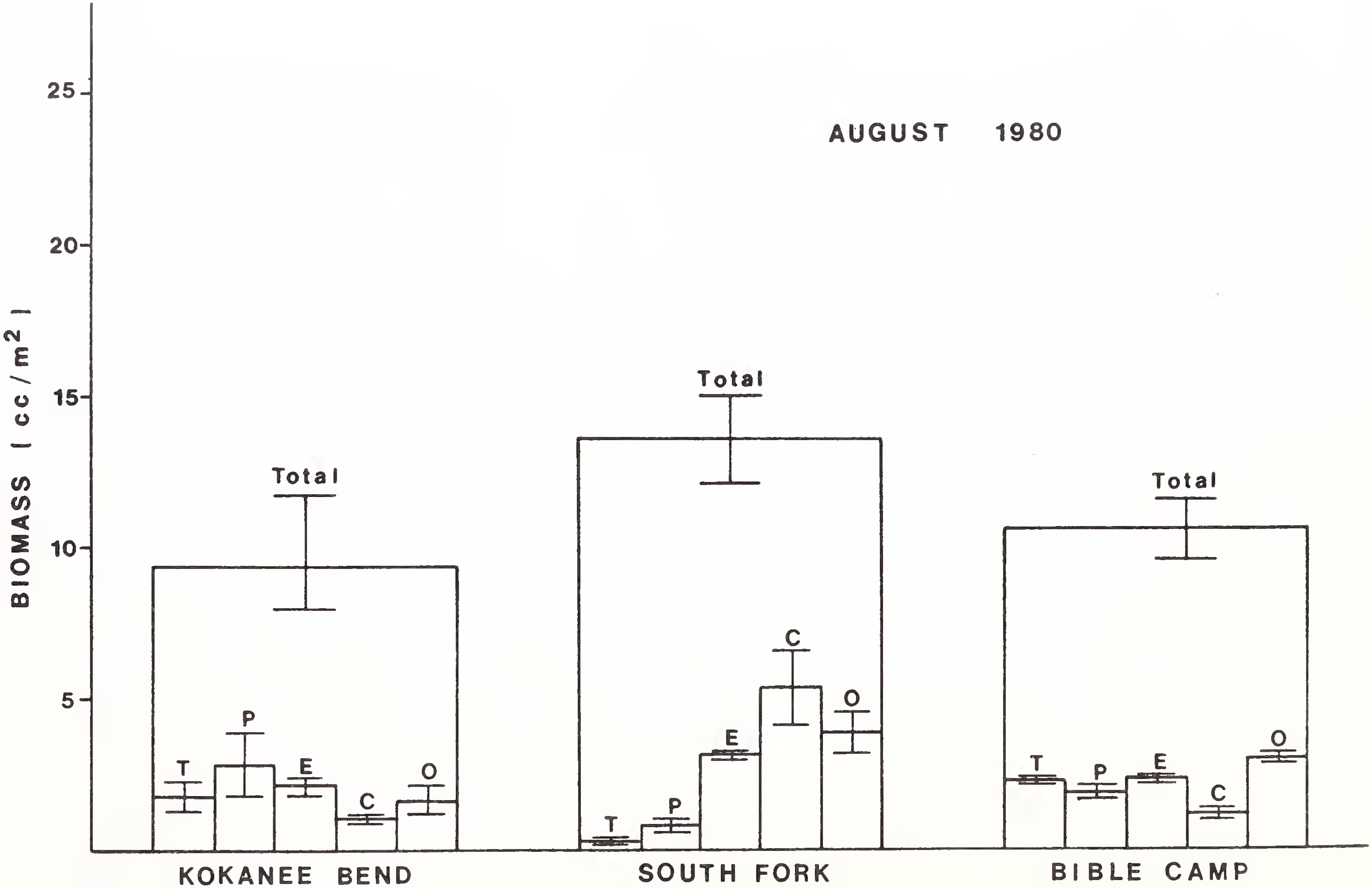
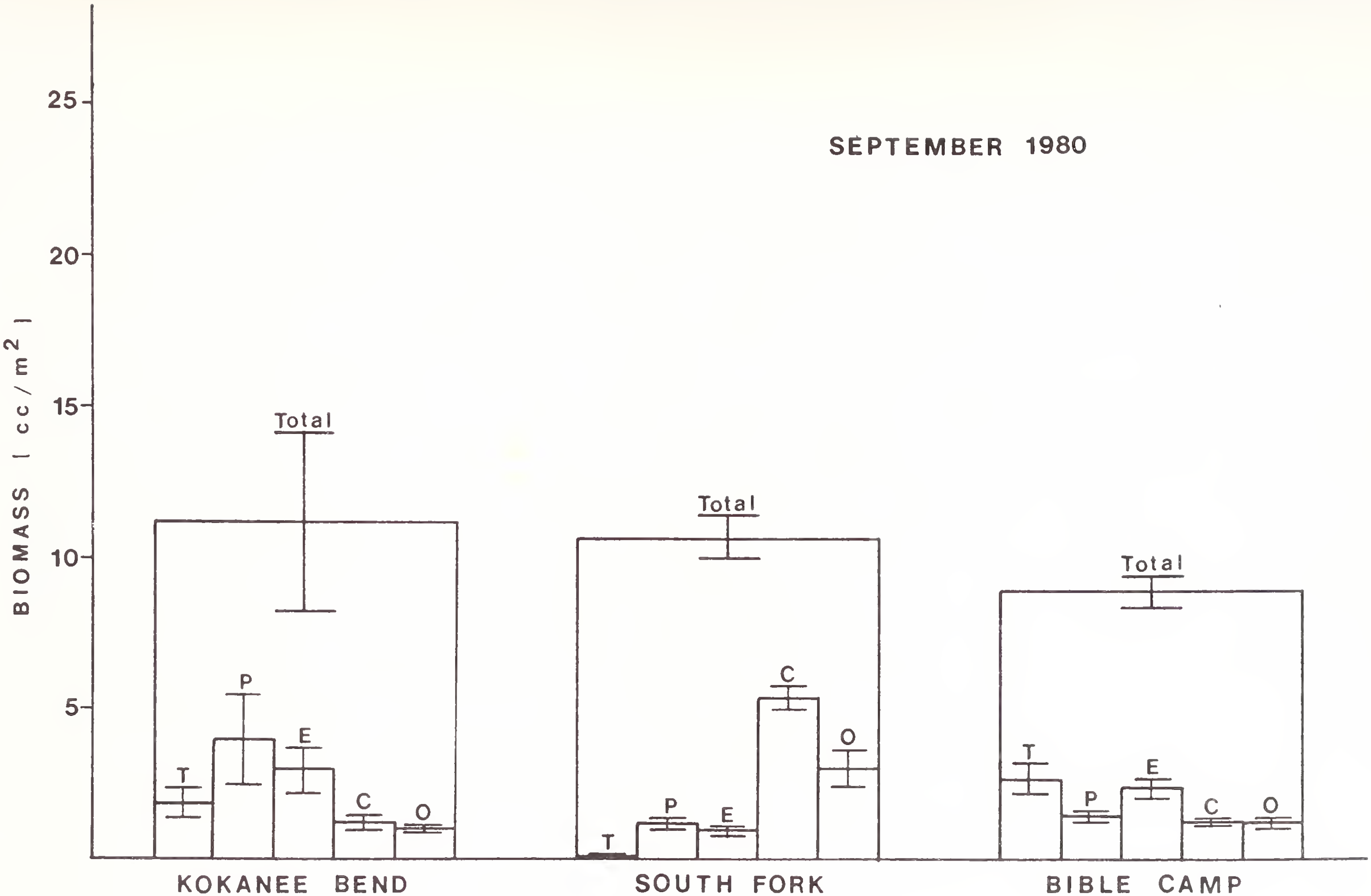

AUGUST 1980
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 37



SEPTEMBER 1980
BIOMASS (cc / m2)
25
20
15
10
5
Total
T
P
E
C
O
KOKANEE BEND
SOUTH FORK
BIBLE CAMP

Figure 38

APPENDIX C

TAXA COLLECTED DECEMBER 1979 THROUGH SEPTEMBER 1980

$\bar{x}$ = mean number/m^2 s.d. = standard deviation

DECEMBER
(12-20-79)

	Bible Camp	Kokanee Bend		South Fork	
	Kick n=7 ($\bar{x}$, s.d.)	Kick n=4	Circular n=4 ($\bar{x}$, s.d.)	Kick n=4	Cirular n=4 ($\bar{x}$, s.d.)
EPHEMEROPTERA					
Siphlonuridae					
Ameletus cooki	3(5)	----	----	----	----
Ameletus sparsatus	10(14)	----	----	----	----
small Siphlonuridae	9(15)	----	----	----	----
Baetidae					
Baetis tricaudatus	389(159)	141(31)	87(101)	163(51)	105(77)
Baetis hageni	152(171)	4(6)	20(39)	----	----
Heptageniidae					
Rhithrogena hageni	1,483(547)	422(210)	260(269)	----	----
Rhithrogena robusta	3(5)	----	----	8(15)	----
Epeorus grandis	----	----	----	0.8(2)	2(3)
Epeorus sp.	123(167)	----	----	----	----
Cinygmula sp.	734(844)	49(43)	108(206)	----	6(12)
small Heptageniidae	----	----	----	43(53)	6(12)
Ephemerellidae					
Ephemerella doddsi	16(9)	11(11)	17(17)	----	0.8(2)
Ephemerella spinifera	----	0.9(2)	----	----	----
Ephemerella inermis	288(145)	26(25)	51(100)	----	0.8(2)
Leptophlebiidae					
Paraleptophlebia heteronea	82(85)	----	2(3)	----	----
PLECOPTERA					
Pteronarcidae					
Pteronarcys californica	0.3(1)	----	2(3)	----	----
Pteronarcella badia	0.9(2)	41(22)	43(35)	----	----
Taeniopterygidae					
Taenionema pacificum	303(224)	97(77)	56(43)	44(23)	26(28)

DECEMBER (Continued)

	Bible Camp Kick n=7 ($\bar{x}$, s.d.)	Kokanee Bend Kick n=4 ($\bar{x}$, s.d.)	Kokanee Bend Circular n=4 ($\bar{x}$, s.d.)	South Fork Kick n=4 ($\bar{x}$, s.d.)	South Fork Circular n=4 ($\bar{x}$, s.d.)
Nemouridae					
Zapada cinctipes	3(6)	----	----	15(12)	8(15)
Zapada columbiana	----	----	----	21(25)	6(5)
Prostoia besametsa	----	----	7(14)	----	----
Capniidae					
Utacapnia sp.	42(45)	122(100)	0.9(2)	----	----
Capnia sp.	163(197)	----	95(93)	----	----
Capnia sp. A	9(9)	----	----	----	----
small Capniidae	75(143)	182(192)	----	55(36)	8(11)
Leuctridae					
small Leuctridae	----	----	----	----	2(8)
Perlidae					
Classenia sabulosa	11(13)	11(15)	7(10)	----	----
Hesperaperla pacifica	6(6)	0.9(2)	5(5)	----	----
Doroneuria theodora	----	----	----	0.8(2)	----
small Perlidae	0.3(1)	----	30(60)	----	----
Perlodidae					
Isogenoides colubrinus	----	3(4)	0.9(1.5)	----	----
Diura knowltoni	----	----	6(12)	12(24)	14(23)
Setvena bradleyi	----	----	----	0.8(2)	----
Isoperla fulva	15(9)	23(19)	26(47)	----	----
Isoperla patricia	----	----	5(9)	----	----
small perlodidae	----	----	30(60)	----	----
Chloroperlidae					
Sweltsa coloradensis	4(3)	2(3)	2(3)	0.8(2)	----
Trisnaka sp.	0.3(1)	20(7)	----	8(15)	2(2)
Suwallia sp.	----	----	----	8(2)	----
small Chloroperlidae	12(14)	58(66)	80(60)	----	----

DECEMBER (continued)

	Bible Camp	Kokanee Bend		South Fork	
	Kick	Kick	Circular	Kick	Circular
	n=7	n=4	n=4	n=4	n=4
	$\bar{x}$(s.d.)	$\bar{x}$(s.d.)	$\bar{x}$(s.d.)	$\bar{x}$(s.d.)	$\bar{x}$(s.d.)
TRICHOPTERA					
Hydropsychidae					
Arctopsyche grandis	0.9(2)	45(19)	144(268)	----	----
Symphitopsyche oslari	51(59)	6(12)	32(61)	----	----
Symphitopsyche cockerelli	15(11)	0.9(2)	5(9)	----	----
Hydropsyche occidentalis	27(55)	----	3(6)	0.8(2)	----
small Hydropsychidae	112(81)	12(10)	62(95)	----	----
Rhyacophilidae					
Rhyacophila bifila	0.3(1)	----	----	0.8(2)	----
Rhyacophila vao	----	----	0.9(2)	----	----
Rhyacophila vepulsa	----	----	----	0.8(2)	----
Glossosomatidae					
Glossosoma sp.	2(2)	278(186)	80(62)	----	----
Brachycentridae					
Brachycentrus sp.	----	----	8(15)	----	----
Lepidostomatidae					
Lepidostoma sp.	2(5)	----	----	----	----
COLEOPTERA					
Elmidae					
Zaitzevia parvula	----	3(6)	----	----	----
Optioservus quadrimaculatus	----	----	0.9(2)	----	----
DIPTERA					
Tipulidae					
Hexatoma sp.	5(5)	6(8)	2(2)	----	----
Antocha sp.	0.3(1)	----	----	----	----
Tanyderidae					
Protanyderus sp.	----	0.9(2)	0.9(2)	----	----

DECEMBER (continued)

	Bible Camp	Kokanee Bend		South Fork	
	Kick n=7	Kick n=4	Circular n=4	Kick n=4	Circular n=4
	($\bar{x}$, s.d.)	($\bar{x}$, s.d.)		($\bar{x}$, s.d.)	
Simuliidae					
Simulium sp.	6(13)	7(6)	3(6)	----	----
Simulium arcticum pupae	----	0.9(2)	----	----	----
Chironomidae					
Chironomidae larvae	1,308(1,030)	1,087(1,004)	935(1,157)	----	----
Athericidae					
Atherix variegata	2(2)	2(3)	5(7)	----	----
Empididae					
Chelifera sp.	0.9(2)	3(6)	----	----	----
OTHER INVERTEBRATES					
Turbellaria	6(12)	10(12)	----	313(284)	0.8(2)
Nematoda	4(9)	11(8)	6(12)	----	7(12)
Oligochaeta	----	----	----	----	----
Lumbriculidae	1(2)	10(12)	7(12)	410(126)	65(39)
Naididae	----	27(46)	773(1,454)	31(37)	24(48)
Hydracarina	18(31)	30(60)	26(37)	86(92)	18(12)
Piscicola	0.3(1)	----	----	----	----

JANUARY
(1-15-80)

	Kokanee Bend Kick n=8 $\bar{x}$ (s.d.)	South Fork Kick n=8 $\bar{x}$ (s.d.)
EPHEMEROPTERA		
Baetidae		
Baetis tricaudatus	202(254)	378(392)
Baetis hageni	6(11)	----
Heptageniidae		
Rhithrogena hageni	377(401)	----
Rhithrogena robusta	0.9(2)	0.3(0.9)
Epeorus sp.	3(8)	----
Cinygmula sp.	135(166)	----
small Heptageniidae	----	13(19)
Ephemerellidae		
Ephemerella doddsi	7(11)	----
Ephemerella inermis	63(97)	----
Ephemerella spinifera	0.3(1)	----
Leptophlebiidae		
Paraleptophlebia heteronea	4(10)	----
PLECOPTERA		
Pteronarcidae		
Pteronarcys californica	10(25)	----
Pteronarcella badia	38(43)	----
Taeniopterygidae		
Taenionema pacificum	110(89)	7(7)
Nemouridae		
Zapada cinctipes	4(5)	5(9)
Zapada columbiana	----	4(4)
Prostoia besametsa	1(1)	----
Capniidae		
Utacapnia sp.	21(16)	----
Capnia sp.	30(37)	----
Capnia sp. A	2(4)	----
small Capniidae	59(121)	30(33)
Perlidae		
Classenia sabulosa	5(5)	----
Hesperaperla pacifica	1(2)	----
small Perlidae	3(4)	----
Perlodidae		
Isogenoides colubrinus	0.9(2)	----
Megarcys watertoni	----	----
Diura knowltoni	2(4)	27(28)
Kogotus modestus	----	0.3(0.9)
Isoperla fulva	35(41)	----
Isoperla patricia	5(13)	----
small Perlodidae	0.9(2)	----

JANUARY (continued)

	Kokanee Bend Kick n=8 $\bar{x}$ (s.d.)	South Fork Kick n=8 $\bar{x}$ (s.d.)
Chloroperlidae		
Sweltsa coloradensis	4(5)	1(2)
Trisnaka sp.	34(41)	----
small Chloroperlidae	57(78)	----
TRICHOPTERA		
Hydropsychidae		
Arctopsyche grandis	151(219)	----
Symphitopsyche oslari	3(6)	----
Symphitopsyche cockerelli	1(2)	----
Hydropsyche occidentalis	3(6)	----
small Hydropsychidae	23(52)	----
Rhyacophilidae		
Rhyacophila angelita	2(4)	----
Rhyacophila bifila	2(2)	----
Rhyacophila coloradensis	0.3(1)	----
Glossosomatidae		
Glossosoma sp.	242(324)	----
Brachycentridae		
Brachycentrus sp.	3(6)	----
COLEOPTERA		
Elmidae		
Optioservus quadrimaculatus	2(4)	----
DIPTERA		
Blephariceridae	0.3(1)	----
Tipulidae		
Hexatoma sp.	4(5)	----
Antocha sp.	0.3(1)	----
Simuliidae		
Simulium sp.	13(24)	----
Chironomidae		
Chironomidae larvae	895(983)	10,397(9,253)
Chironomidae pupae	0.3(1)	----
Chironomidae adults	4(5)	----
Tanyderidae		
Protanyderus sp.	0.3(1)	----
Athericidae		
Atherix variegata	7(10)	----
OTHER INVERTEBRATES		
Turbellaria	3(8)	330(206)
Nematoda	2(4)	12(13)
Oligochaeta		
Lumbriculidae	6(10)	446(382)
Naididae	26(50)	59(69)
Hydracarina	14(38)	183(264)

FEBRUARY
(2-11-80)

	Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
COLLEMBOLA	6(12)	----	----	----
EPHEMEROPTERA				
Siphlonuridae				
Ameletus sparsatus	----	6(12)	----	----
small Siphlonuridae	----	24(20)	----	----
Baetidae				
Baetis tricaudatus	76(63)	248(228)	362(101)	191(32)
Baetis hageni	0.9(2)	----	----	----
Heptageniidae				
Rhithrogena hageni	175(150)	383(378)	----	----
Epeorus sp.	----	----	----	----
Cinygmula sp.	176(291)	479(555)	33(62)	1(2)
Ephemerellidae				
Ephemerella doddsi	2(2)	7(8)	----	----
Ephemerella inermis	23(25)	54(44)	----	----
Ephemerella sp.	----	----	1(2)	----
Leptophlebiidae				
Paraleptophlebia heteronea	----	2(3)	----	----
PLECOPTERA				
Pteronarcidae				
Pteronarcys californica	----	2(3)	----	----
Pteronarcella badia	6(7)	68(84)	----	----
Taeniopterygidae				
Taenionema pacificum	275(183)	96(68)	17(35)	----
Nemouridae				
Zapada cinctipes	8(11)	2(2)	22(26)	2(2)
Zapada columbiana	----	----	10(16)	1(2)
Prostoia besametsa	6(7)	13(16)	----	2(2)
small Nemouridae	6(12)	6(12)	----	----
Capniidae				
Utacapnia sp.	110(81)	19(25)	2(5)	----
Capnia sp.	----	259(243)	56(70)	6(5)
small Capniidae	461(138)	----	6(12)	9(18)
Perlidae				
Classenia sabulosa	0.9(2)	17(31)	----	----
Hesperaperla pacifica	----	14(26)	----	----
Doroneuria theodora	----	----	1(2)	----
Perlodidae				
Skwala parallela	----	0.9(2)	----	----
Diura knowltoni	2(2)	0.9(2)	9(8)	9(11)
Isoperla fulva	3(2)	35(50)	----	----

FEBRUARY (continued)

	Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Chloroperlidae				
Sweltsa coloradensis	2(3)	7(10)	----	----
Trisnaka sp.	0.9(2)	53(65)	----	----
small Chloroperlidae	41(44)	110(56)	----	7(12)
TRICHOPTERA				
Hydropsychidae				
Arctopsyche grandis	4(3)	147(212)	----	----
Symphitopsyche oslari	----	4(8)	----	----
Symphitopsyche cockerelli	----	2(5)	----	----
Hydropsyche occidentalis	----	2(2)	----	----
small Hydropsychidae	----	12(24)	----	----
Rhyacophilidae				
Rhyacophila coloradensis	----	----	1(2)	----
Rhyacophila verrula	----	----	9(16)	1(2)
small Rhyacophila sp.	----	----	2(3)	13(15)
Glossosomatidae				
Glossosoma sp.	70(63)	236(188)	----	----
Hydroptilidae				
Ochrotrichia sp.	0.9(2)	----	----	----
Brachycentridae				
Brachycentrus sp.	----	0.9(2)	----	----
DIPTERA				
Simuliidae				
Simulium sp.	29(21)	24(48)	68(137)	1(2)
Chironomidae				
Chironomidae larvae	1,220(764)	1,417(1,273)	10,081(8,250)	7,541(2,671)
Chironomidae pupae	----	----	2(5)	----
Chironomidae adults	0.9(2)	----	----	----
Athericidae				
Atherix varietaga	2(3)	2(2)	----	----
Empididae				
Hemerodromia sp.	----	6(12)	----	----
OTHER INVERTEBRATES				
Turbellaria	----	5(7)	402(30)	72(17)
Nematoda	19(38)	----	6(12)	----
Oligochaeta				
Lumbriculidae	3(4)	3(4)	258(121)	131(131)
Naididae	15(14)	38(57)	102(204)	36(31)
Hydracarina	----	36(31)	354(342)	36(72)
Hirudinea				
Piscicola	----	2(3)	----	----

MARCH (3-14-80)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
EPHEMEROPTERA						
Siphlonuridae						
Ameletus cooki	31(59)	9(11)	44(87)	----	----	----
Ameletus sparsatus	23(25)	236(413)	----	----	----	----
small Siphlonuridae	65(131)	31(62)	----	95(43)	----	----
Baetidae						
Baetis tricaudatus	179(200)	265(325)	161(74)	171(69)	543(322)	378(291)
Baetis hageni	409(341)	181(210)	----	----	----	----
Heptageniidae						
Rhithrogena hageni	2,783(1,256)	1,646(912)	224(154)	178(65)	----	----
Rhithrogena robusta	----	----	----	----	0.9(2)	0.9(2)
Epeorus sp.	92(96)	119(81)	0.9(2)	----	----	----
Epeorus grandis	----	----	----	----	2(5)	----
Cinygmula sp.	377(199)	761(295)	80(111)	167(186)	38(56)	42(41)
Ephemerellidae						
Ephemerella doddsi	22(13)	11(8)	9(8)	3(2)	----	----
Ephemerella inermis	189(26)	185(49)	18(10)	16(23)	----	----
Ephemerella flavilinea	----	----	----	4(8)	----	----
Ephemerella heterocaudata	----	----	----	----	6(12)	----
Ephemerella sp.	----	----	----	----	25(48)	6(12)
Leptophlebiidae						
Paraleptophlebia heteronea	59(43)	51(12)	----	----	----	----
PLECOPTERA						
Pteronarcidae						
Pteronarcella badia	2(3)	3(6)	50(55)	18(25)	----	----
Taeniopterygidae						
Taenionema pacificum	197(367)	123(160)	251(117)	229(45)	8(13)	2(3)

MARCH (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Nemouridae						
Zapada cinctipes	0.9(2)	2(3)	----	----	74(125)	3(2)
Zapada columbiana	----	----	----	----	12(20)	23(34)
Prostoia besametsa	0.9(2)	0.9(2)	8(5)	8(5)	2(3)	----
Capniidae						
Utacapnia sp.	5(7)	2(5)	4(6)	----	----	----
Capnia confusa		0.9(2)	0.9(2)	2(2)	0.9(2)	
Capnia sp.	423(719)	188(284)	301(331)	470(310)	27(21)	6(6)
Capnia sp. A	7(4)	5(3)	2(3)	2(3)	----	----
Perlidae						
Classenia sabulosa	14(9)	20(16)	2(2)	10(7)	----	----
Hesperoperla pacifica	3(2)	5(5)	3(6)	2(3)	----	----
small Perlidae	----	----	----	3(6)	----	----
Perlodidae						
Isogenoides colubrinus	----	----	----	0.9(2)	----	----
Diura knowltoni	----	----	----	----	34(31)	17(21)
Isoperla fulva	14(17)	8(8)	10(11)	9(14)	----	----
Isoperla patricia	----	0.9(2)	0.9(2)	0.9(2)	----	----
small Perlodidae	0.9(2)	----	----	----	----	----
Chloroperlidae						
Sweltsa coloradensis	5(6)	----	5(7)	4(6)	----	----
Triznaka sp.	8(13)	8(5)	22(11)	67(92)	----	----
small Chloroperlidae	12(17)	3(4)	58(23)	140(111)	7(14)	----
TRICHOPTERA						
Hydropsychidae						
Arctopsyche grandis	----	6(5)	65(72)	58(76)	----	----
Parapsyche elsis	----	----	----	----	0.9(2)	----
Symphitopsyche oslari	17(11)	78(69)	----	0.9(2)	----	----
Symphitopsyche cockerelli	9(6)	11(10)	0.9(2)	----	----	----
Hydropsyche occidentalis	9(12)	38(62)	----	2(3)	----	----
small Hydropsychidae	31(35)	60(50)	23(25)	3(6)	----	----

MARCH (continued)

	Bible Creek		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Rhyacophilidae						
Rhyacophila angelita	2(3)	----	----	----	----	----
Rhyacophila vaccua	----	----	0.9(2)	----	----	----
Rhyacophila verrula	----	----	----	----	13(23)	11(13)
Rhyacophila vepulsa	----	----	----	----	----	0.9(2)
Glossosomatidae						
Glossosoma sp.	3(6)	----	95(29)	105(23)	----	6(12)
Hydroptilidae						
Ochrotrichia sp.	----	0.9(2)	----	----	----	----
Brachycentridae						
Brachycentrus sp.	----	----	0.9(2)	----	----	----
DIPTERA						
Tipulidae						
Hexatoma sp.	7(5)	2(2)	2(3)	0.9(2)	----	----
Antocha sp.	----	----	----	2(3)	----	----
Simuliidae						
Simulium sp.	10(20)	18(36)	29(45)	58(16)	----	102(188)
Chironomidae						
Chironomidae larvae	1,277(836)	1,881(1,407)	1,214(466)	1,385(544)	14,092(4,695)	10,009(6,259)
Chironomidae pupae	0.9(2)	6(12)	4(8)	2(2)	159(69)	66(50)
Chironomidae adults	----	0.9(2)	----	----	0.9(2)	----
Tanyderidae						
Protanyderus sp.	----	----	0.9(2)	----	----	----
Athericidae						
Atherix variegata	0.9(2)	2(3)	7(10)	2(3)	----	----
Empididae						
Chelifera sp.	----	----	----	----	----	----

MARCH (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n-4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
OTHER INVERTEBRATES						
Turbellaria	8(6)	8(5)	6(8)	2(3)	314(101)	292(130)
Nematoda	7(14)	0.9(2)	3(6)	17(23)	30(45)	36(31)
Oligochaeta						
Lumbriculidae	17(27)	4(8)	19(20)	17(12)	259(58)	366(211)
Naididae			22(28)	48(56)	96(104)	66(77)
Hydracarina	28(56)	24(34)	-----	6(12)	870(1,073)	319(280)

APRIL (4-15-80)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
EPHEMEROPTERA						
Siphlonuridae						
Ameletus cooki	----	0.9(2)	----	----	----	----
Ameletus sparsatus	26(35)	3(2)	----	----	----	----
small Siphlonuridae	184(164)	244(166)	266(146)	146(79)	12(14)	6(12)
Baetidae						
Baetis tricaudatus	544(790)	471(464)	1,488(673)	610(312)	422(181)	98(63)
Baetis hageni	229(198)	130(112)	13(23)	2(3)	----	----
Baetis bicaudatus	----	----	----	----	357(93)	85(52)
Heptageniidae						
Rhithrogena hageni	1,947(1,646)	551(690)	173(136)	87(66)	----	----
Rhithrogena robusta	10(11)	6(4)	6(5)	----	5(5)	2(2)
Epeorus sp.	101(79)	54(42)	8(6)	8(8)	----	----
Epeorus grandis	----	----	----	----	11(13)	0.9(2)
Cinygmula sp.	651(433)	519(437)	164(37)	63(26)	116(43)	26(20)
Ephemerellidae						
Ephemerella doddsi	8(9)	6(2)	2(5)	0.9(2)	----	----
Ephemerella inermis	359(150)	107(67)	55(47)	12(11)	----	----
Ephemerella tibialis	----	----	----	----	85(59)	----
Ephemerella flavilinea	----	----	----	----	0.9(2)	----
Ephemerella heterocaudata	----	----	----	----	0.9(2)	----
small Ephemerella sp.	----	----	90(74)	----	42(84)	13(13)
Leptophlebiidae						
Paraleptophlebia heteronea	60(32)	38(30)	----	----	----	----
PLECOPTERA						
Pteronarcidae						
Pteronarcys californica	----	0.9(2)	2(3)	----	----	----
Pteronarcella badia	3(5)	0.9(2)	19(24)	25(30)	----	----
Taeniopterygidae						
Taenionema pacificum	38(66)	70(62)	5(2)	5(4)	----	0.9(2)

APRIL (4-15-80)
(continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Nemouridae						
Zapada cinctipes	----	----	----	4(6)	0.9(2)	13(26)
Zapada columbiana	----	----	----		47(56)	15(14)
Suwallia pallidula	----	----	----	----	----	6(12)
Prostoia besametsa	----	----	16(10)	5(6)	8(11)	----
small Nemouridae	----	----	----	2(3)	6(12)	6(12)
Capniidae						
Utacapnia sp.	9(16)	----	----	----	----	----
Capnia confusa	105(182)	8(5)	34(31)	6(4)	----	----
Capnia sp.	----	52(52)	100(99)	27(19)	3(4)	0.9(2)
Capnia sp. A	----	5(5)	----	----	----	----
Isocapnia sp.	----	----	----	----	----	6(12)
Perlidae						
Calineuria californica	----	----	----	----	----	0.9(2)
Classenia sabulosa	----	5(7)	3(4)	2(2)	----	----
Hesperaperla pacifica	----	3(0)	0.9(2)	----	----	----
small Perlidae	----	----	9(18)	6(12)	----	----
Perlodidae						
Diura knowltoni	0.9(2)	----	----	----	13(12)	5(2)
Isoperla fulva	6(11)	2(3)	2(2)	4(6)	----	----
Isoperla patricia	----	----	----	2(2)	----	----
small Perlodidae	----	----	----	3(6)	----	----
Chloroperlidae						
Sweltsa coloradensis	----	2(2)	0.9(2)	----	0.9(2)	----
Trisnaka sp.	----	3(2)	5(4)	3(4)	----	----
small Chloroperlidae	----	15(23)	84(61)	23(14)	6(12)	----
TRICHOPTERA						
Hydropsychidae						
Arctopsyche grandis	0.9(2)	----	146(285)	26(41)	----	----
Symphitopsyche oslari	18(13)	2(3)	----	----	----	----
Symphitopsyche cockerelli	2(4)	0.9(2)	----	----	----	----

APRIL (4-15-80)
(continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Hydropsychidae (cont.)						
Hydropsyche occidentalis	----	5(5)	----	----	----	----
small Hydropsychidae	64(5)	32(38)	----	3(6)	----	----
Rhyacophilidae						
Rhyacophila coloradensis	----	----	----	----	0.9(2)	----
Rhyacophila bifila	----	----	----	----	2(3)	----
Rhyacophila verrula	----	----	----	----	32(42)	14(11)
Glossosomatidae						
Glossosoma sp.	5(2)	----	113(69)	60(43)	----	----
Hydroptilidae						
Ochrotrichia sp.	----	----	18(23)	7(8)	----	----
Brachycentridae						
Brachycentrus sp.	2(4)	2(2)	----	0.9(2)	----	----
COLEOPTERA						
Elmidae						
Optioservus quadrimaculatus	----	2(2)	----	2(3)	----	----
DIPTERA						
Tipulidae						
Hexatoma sp.	21(31)	7(14)	2(2)	2(3)	----	----
Simuliidae						
Simulium sp.	83(56)	99(50)	947(626)	564(522)	1,909(687)	66(82)
Chironomidae						
Chironomidae larvae	1,357(852)	1,350(664)	2,472(609)	875(240)	12,016(3,928)	6,755(2,213)
Chironomidae pupae	8(13.9)	20(23)	135(68)	20(13)	1,503(500)	405(217)
Chironomidae adults	42(39)	4(5)	11(12)	3(0)	322(96)	80(94)
Tanyderidae						
Protanyderus sp.	----	-----	0.9(2)	----	----	-----

APRIL (4-15-80)
(continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Athericidae						
Atherix variegata	2(4)	----	0.9(2)	0.9(2)	----	----
Empididae						
Chelifera sp.	-----	----	0.9(2)	----	----	----
OTHER INVERTEBRATES						
Turbellaria	2(2)	----	----	0.9(2)	648(149)	311(92)
Nematoda	----	18(36)	2(3)	0.9(2)	6(12)	6(12)
Oligochaeta						
Lumbriculidae	2(4)	2(3)	55(110)	11(12)	443(205)	238(96)
Naididae	0.9(2)	----	94(76)	30(26)	97(81)	108(57)
Hydracarina	9(13)	6(12)	156(249)	39(29)	326(217)	120(76)

MAY (5-12-80)

	South Fork Kick n=4 $\bar{x}$(s.d.)
EPHEMEROPTERA	
Siphlonuridae	
small Siphlonuridae	12(14)
Baetidae	
Baetis tricaudatus	288(98)
Baetis bicaudatus	326(174)
Heptageniidae	
Cinygmula sp.	114(133)
Rhithrogena robusta	0.9(2)
Epeorus grandis	0.9(2)
Ephemerellidae	
Ephemerella doddsi	38(47)
Ephemerella flavilinea	0.9(2)
Ephemerella heterocaudata	0.9(2)
Ephemerella tibialis	6(12)
PLECOPTERA	
Perlodidae	
Diura knowltoni	41(43)
Chloroperlidae	
Sweltsa coloradensis	5(4)
Pteronarcella badia	13(13)
small Chloroperlidae	6(12)
Nemouridae	
Zapada columbiana	59(41)
Capniidae	
Capnia sp.	6(12)
Isocapnia sp.	0.9(2)
TRICHOPTERA	
Rhyacophilidae	
Rhyacophila bifila	0.9(2)
Rhyacophila verrula	6(4)
Rhyacophila vagrita	0.9(2)
small Rhyacophila	6(12)
DIPTERA	
Chironomidae	
Chironomidae larvae	8,611(3,341)
Chironomidae pupae	252(224)
Chironomidae adults	35(39)
Simullidae	
Simulium sp.	494(409)

MAY (continued)

	South Fork Kick n=4 $\bar{x}$(s.d.)
OTHER INVERTEBRATES	
Turbellaria	302(353)
Lumbriculidae	417(371)
Naididae	132(233)
Hydracarina	186(248)

JUNE (6-8-80)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
EPHEMEROPTERA						
Siphlonuridae						
Ameletus sparsatus	8(15)	----	1(2)	5(4)	----	----
small Siphlonuridae	13(23)	----	----	21(20)	6(12)	----
Baetidae						
Baetis tricaudatus	783(607)	195(33)	257(68)	315(99)	14(6)	3(2)
Baetis bicaudatus	----	----	----	----	56(49)	27(10)
Baetis hageni	134(69)	26(33)	32(37)	101(102)	----	----
Pseudocleon sp.	167(278)	39(47)	6(12)	260(177)	----	----
Heptageniidae						
Rhithrogena hageni	1,121(506)	539(244)	176(128)	59(33)	----	----
Rhithrogena robusta	8(4)	3(4)	1(2)	----	1(2)	----
Epeorus sp.	281(158)	131(47)	52(18)	74(48)	----	----
Cinygmula sp.	1,168(859)	269(103)	300(94)	458(167)	61(34)	50(49)
Ephemerellidae						
Ephemerella doddsi	8(6)	4(3)	3(3)	----	12(14)	1(2)
Ephemerella inermis	68(40)	50(9)	126(103)	126(52)	----	----
Ephemerella tibialis	150(93)	68(52)	423(373)	737(545)	----	----
Ephemerella flavilinea	50(48)	26(33)	9(7)	18(32)	----	1(2)
Ephemerella heterocaudata	2(3)	----	----	1(2)	----	1(2)
Ephemerella spinifera	----	----	----	1(2)	----	----
small Ephemerella sp.	55(52)	69(48)	55(47)	148(169)	----	6(12)
Leptophlebiidae						
Paraleptophlebia heteronea	8(5)	7(6)	1(2)	6(8)	----	----
PLECOPTERA						
Pteronarcidae						
Pteronarcys californica	----	----	----	4(3)	----	----
Pteronarcella badia	221(182)	99(102)	38(26)	73(58)	----	----

JUNE (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Nemouridae						
Zapada columbiana	----	----	----	----	1(2)	----
small Nemouridae	----	----	12(24)	----	----	----
Capniidae						
Isocapnia sp.	----	----	----	----	6(12)	1(2)
Capnia sp.	----	----	----	----	6(12)	----
Perlidae						
Classenia sabulosa	----	8(11)	4(3)	3(2)	----	----
Hesperaperla pacifica	2(2)	----	----	5(5)	----	----
small Perlidae	----	----	----	27(34)	----	----
Perlodidae						
Skwala parallela	0.9(2)	----	----	----	----	----
Isogenoides colubrinus	2(2)	1(2)	1(2)	2(3)	----	----
Diura knowltoni	0.9(2)	----	----	----	8(7)	11(6)
Isoperla fulva	8(9)	5(3)	25(24)	5(5)	----	----
Isoperla patricia	----	1(2)	----	----	----	----
small Perlodidae	8(13)	----	----	18(36)	----	----
Chloroperlidae						
Sweltsa coloradensis	5(6)	2(2)	----	1(2)	0.3(1)	----
Triznaka sp.	62(22)	8(11)	8(5)	13(3)	----	----
Suwallia pallidula	----	17(20)	----	----	2(4)	----
Suwallia autumna	20(41)	----	----	----	2(3)	2(3)
Utaperla sopladora	0.9(2)	----	----	----	----	----
small Chloroperlidae	19(14)	14(10)	3(4)	17(12)	----	----
TRICHOPTERA						
Hydropsychidae						
Arctopsyche grandis	----	----	1(2)	----	----	----
Symphitopsyche oslari	30(22)	38(12)	17(14)	8(11)	----	----
Symphitopsyche cockerelli	0.9(2)	1(2)	----	----	----	----
Hydropsyche occidentalis	19(18)	16(8)	7(8)	4(4)	----	----
small Hydropsychidae	3(6)	3(4)	7(12)	----	----	----

JUNE (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Rhyacophilidae						
Rhyacophila angelita	3(6)	3(6)	2(2)	1(2)	1(2)	----
Rhyacophila bifila	----	----	1(2)	----	1(2)	----
Rhyacophila verrula	----	----	----	----	----	1(2)
small Rhyacophila sp.	6(12)	----	----	6(7)	7(12)	----
Glossosomatidae						
Glossosoma sp.	3(4)	1(2)	1(2)	----	----	----
Brachycentridae						
Brachycentrus sp.	8(13)	----	9(11)	----	----	----
Limnephilidae						
Onocosmoecus sp.	2(2)	----	----	----	----	----
COLEOPTERA						
Elmidae						
Optioservus quadrimaculatus	6(12)	----	----	----	----	----
Brychius sp.	----	----	2(3)	----	----	----
DIPTERA						
Blephariceridae	-----	7(14)	----	----	----	----
Tipulidae						
Hexatoma sp.	0.9(2)	1(2)	1(2)	----	----	----
Simuliidae						
Simulium sp.	328(115)	104(29)	4,880(4,133)	4,186(5,390)	35(41)	20(33)
Simulium arcticum pupae	----	1(2)	9(18)	1(2)	6(12)	----
Chironomidae						
Chironomidae larvae	2,471(1,538)	1,654(1,182)	1,280(367)	3,380(1,353)	6,761(2,084)	6,724(572)
Chironomidae pupae	----	----	36(31)	32(23)	413(358)	145(122)
Chironomidae adults	13(23)	9(11)	50(30)	6(12)	25(15)	19(24)
Tanyderidae						
Protanyderus sp.	0.9(2)	1(2)	1(2)	----	----	----
Atherididae						
Atherix variegata	0.9(2)	1(2)	1(2)	----	----	----

JUNE (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Empididae						
Chelifera sp.	----	----	6(12)	----	----	----
OTHER INVERTEBRATES						
Turbellaria	----	----	----	----	450(293)	167(59)
Nematoda	----	----	----	----	48(39)	6(12)
Hirudinea						
Piscicola	0.9(2)	----	----	----	----	----
Oligochaeta						
Lumbriculidae	----	18(36)	20(25)	226(252)	646(413)	181(128)
Naididae	6(12)	----	194(127)	50(37)	120(127)	408(464)
Hydracarina	6(12)	9(11)	26(49)	33(66)	822(582)	210(103)
COLLEMBOLA	12(24)	----	----	6(12)	----	----

JULY (7-11-80)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
EPHEMEROPTERA						
Siphlonuridae						
small Siphlonuridae	7(12)	16(23)	1(2)	----	----	----
Baetidae						
Baetis tricuadatus	635(438)	572(162)	452(213)	70(50)	20(22)	2(2)
Baetis bicaudatus	36(34)	6(5)	5(4)	----	95(41)	47(27)
Baetis hageni	60(18)	28(8)	317(311)	14(21)	----	----
Baetis propinquus	12(14)	7(8)	1(2)	----	----	----
Pseudocleon sp.	254(129)	174(68)	400(272)	156(112)	----	----
Heptageniidae						
Rhithrogena hageni	89(55)	56(26)	273(182)	81(90)	----	1(2)
Epeorus sp.	176(65)	92(18)	365(145)	39(26)	----	----
Epeorus longimanus	----	----	----	----	3(2)	2(3)
Epeorus deceptivus	----	----	----	----	1(2)	----
small Epeorus sp.	----	----	----	----	12(14)	----
Cinygmula sp.	305(129)	179(53)	318(176)	59(34)	160(75)	117(77)
Ephemerellidae						
Ephemerella doddsi	68(83)	50(55)	39(42)	14(19)	12(14)	----
Ephemerella inermis	5(4)	----	17(20)	3(2)	1(2)	----
Ephemerella tibialis	282(220)	87(24)	485(229)	59(40)	2(3)	2(3)
Ephemerella flavilinea	11(9)	10(12)	52(10)	8(9)	----	----
Ephemerella heterocaudata	1(2)	----	2(3)	2(3)	2(3)	----
Ephemerella spinifera	-----	----	5(4)	1(2)	----	----
small Ephemerella sp.	2(3)	3(6)	----	----	----	----
Leptophlebiidae						
Paraleptophlebia heteronea	2(2)	1(2)	6(7)	1(2)	----	----

JULY (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
PLECOPTERA						
Pteronarcidae						
Pteronarcys californica	----	----	2(2)	----	----	----
Pteronarcella badia	56(45)	18(14)	226(94)	36(32)	----	----
Taeniopterygidae						
Taenionema pacificum	42(49)	52(37)	300(258)	33(26)	----	----
Nemouridae						
Zapada cinctipes	1(2)	3(6)	8(13)	----	----	----
Zapada columbiana	----	----	----	----	19(15)	8(7)
Amphinemura sp.	----	----	----	----	----	1(2)
Visoka cataractae	----	----	----	----	1(2)	----
Capniidae						
Isocapnia sp.	----	----	----	----	2(3)	2(3)
Capnia sp.	----	----	----	----	1(2)	----
small Capniidae	44(59)	18(23)	9(14)	8(5)	----	----
Perlidae						
Classenia sabulosa	2(2)	----	6(8)	2(3)	----	----
Hesperaperla pacifica	21(14)	2(3)	20(26)	----	----	----
small Perlidae	----	39(33)	----	----	----	----
Pelodidae						
Megarcys watertoni	1(2)	----	----	----	----	----
Diura knowltoni	----	----	----	----	11(13)	2(3)
Setvena bradleyi	----	----	----	----	1(2)	----
small Perlodidae	18(23)	6(5)	18(18)	3(4)	----	----
Chloroperlidae						
Sweltsa coloradensis	----	----	----	----	3(2)	2(2)
Suwallia pallidula	11(6)	3(2)	9(12)	----	0.3(2)	2(3)
Suwallia autumna	60(42)	17(9)	71(25)	5(4)	4(3)	1(2)
small Chloroperlidae	7(5)	10(11)	10(18)	5(11)	8(11)	1(2)

JULY (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
TRICHOPTERA						
Hydropsychidae						
Arctopsyche grandis	119(123)	61(73)	81(67)	14(18)	----	----
Symphitopsyche oslari	53(56)	10(12)	26(17)	7(5)	----	----
Hydropsyche occidentalis	27(19)	6(3)	24(21)	4(5)	----	----
small Hydropsychidae	34(51)	14(23)	----	----	----	----
Hydropsychidae pupae	8(7)	2(2)	8(8)	2(3)	----	----
Rhyacophilidae						
Rhyacophila angelita	22(34)	8(6)	12(13)	6(6)	1(2)	1(2)
Rhyacophila bifila	----	----	8(15)	----	----	----
Rhyacophila verrula	----	----	----	----	2(3)	----
Glossosomatidae						
Glossosoma sp.	----	----	2(3)	----	----	----
Brachycentridae						
Brachycentrus sp.	76(86)	14(5)	17(18)	26(53)	----	----
DIPTERA						
Deuterophlebiidae	----	----	1(2)	----	----	----
Blephariceridae	1(2)	2(5)	1(2)	1(2)	----	----
Tipulidae						
Hexatoma sp.	4(2)	----	----	----	----	----
Simuliidae						
Simulium sp.	38(39)	186(156)	270(290)	32(40)	7(12)	4(5)
Chironomidae						
Chironomidae larvae	1,379(484)	938(364)	1,906(766)	323(153)	3,537(2,026)	4,749(1,508)
Chironomidae pupae	30(26)	14(5)	25(7)	7(6)	155(77)	192(48)
Chironomidae adults	33(24)	4(6)	16(9)	5(9)	3(6)	----
Tanyderidae						
Protanyderus sp.	2(3)	1(2)	5(2)	----	----	----
Athericidae						
Atherix variegata	1(2)	----	2(2)	1(2)	----	----

JULY (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
OTHER INVERTEBRATES						
Turbellaria	9(14)	5(5)		1(2)	327(125)	305(118)
Nematoda	----	12(14)	17(27)	11(8)	48(81)	----
Oligochaeta						
Lumbriculidae	9(10)	2(5)	1(2)	2(3)	284(248)	245(128)
Naididae	----	3(6)	450(480)	52(102)	168(163)	138(53)
Hydracarina	19(36)	86(113)	89(94)	8(8)	402(412)	204(329)

AUGUST (8-11-80)

	Bible Camp Kick n=4 x̄(s.d.)	Bible Camp Circular n=4 x̄(s.d.)	Kokanee Bend Kick n=3 x̄(s.d.)	Kokanee Bend Circular n=4 x̄(s.d.)	South Fork Kick n=4 x̄(s.d.)	South Fork Circular n=4 x̄(s.d.)
COLLEMBOLA	----	----	1(2)	----	----	----
EPHEMEROPTERA						
Siphonuridae						
small Siphlonuridae	11(12)	11(13)	11(12)	----	----	----
Baetidae						
Baetis tricaudatus	1,403(766)	1,346(291)	1,632(1,014)	793(268)	200(102)	102(93)
Baetis bicaudatus	----	35(55)	----	----	47(28)	23(7)
Baetis propinquus	----	----	----	2(5)	----	----
Baetis hageni	----	----	4(2)	8(7)	----	----
Pseudocleon sp.	----	----	70(109)	2(3)	----	----
Heptageniidae						
Rhithrogena hageni	371(91)	227(97)	258(73)	66(20)	----	----
Rhithrogena robusta	----	----	82(41)	36(33)	----	----
Epeorus sp.	1(2)	3(4)	60(32)	19(8)	----	----
Epeorus longimanus	----	----	----	----	2(2)	----
Epeorus deceptivus	----	----	----	----	7(14)	1(2)
Epeorus (Iron) sp.	----	----	29(11)	4(6)	----	----
Cinygmula sp.	62(49)	68(74)	141(68)	216(156)	113(71)	62(27)
Ephemerellidae						
Ephemerella doddsi	167(121)	143(57)	56(35)	30(16)	----	----
Ephemerella inermis	5(6)	1(2)	96(159)	46(34)	----	----
Ephemerella tibialis	46(20)	2(3)	124(30)	59(35)	1(2)	1(2)
Ephemerella flavilinea	----	----	2(2)	5(7)	----	----
Ephemerella heterocaudata	----	----	----	----	1(2)	----
Ephemerella spinifera	----	----	8(14)	----	----	----
Leptophlebiidae						
Paraleptophlebia heteronea	2(3)	1(2)	----	3(3)	----	----

AUGUST (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
PLECOPTERA						
Pteronarcidae						
Pteronarcys californica	----	----	4(3)	----	----	----
Pteronarcella badia	3(4)	1(2)	54(58)	23(25)	----	----
Taeniopterygidae						
Taenionema pacificum	----	----	90(48)	49(14)	----	6(12)
Nemouridae						
Zapada cinctipes	----	----	38(56)	19(17)	----	----
Zapada columbiana	----	----	----	----	8(9)	5(4)
Capniidae						
Isocapnia sp.	----	----	----	----	9(18)	----
Capnia sp.	----	----	----	----	----	42(69)
small Capniidae	33(66)	6(7)	233(239)	234(122)	----	
Perlidae						
Classenia sabulosa	25(28)	16(26)	7(8)	7(9)	----	----
Hesperoperla pacifica	23(18)	8(5)	11(14)	17(17)	----	----
small Perlidae	62(38)	29(44)	53(9)	74(84)	----	----
Perlodidae						
Isogenoides colubrinus	----	----	1(2)	----	----	----
Megarcys watertoni	----	----	1(2)	----	----	----
Diura knowltoni	----	----	10(12)	----	12(12)	----
Isoperla patricia	----	----	10(15)	----	----	----
small Perlodidae	----	44(53)	129(47)	17(27)	----	----
Chloroperlidae						
Sweltsa coloradensis	----	----	----	1(2)	1(2)	1(2)
Suwallia pallidula	3(3)	----	4(5)	6(8)	----	----
Suwallia autumna	5(2)	14(25)	23(6)	6(8)	----	----
small Chloroperlidae	1(2)	45(40)	75(64)	25(18)	6(12)	----

AUGUST (continued)

	Bible Camp		Kokanne Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
TRICHOPTERA						
Hydropsychidae						
Arctopsyche grandis	38(30)	43(37)	808(328)	207(89)	----	----
Parapsyche elsis	----	----	----	----	1(2)	----
Symphitopsyche oslari	17(15)	11(11)	9(5)	3(3)	----	----
Symphitopsyche cockerelli	86(65)	83(74)	27(15)	21(38)	----	----
Hydropsyche occidentalis	17(20)	11(14)	6(10)	----	----	----
small Hydropsychidae	119(126)	350(319)	27(47)	11(21)	----	----
Hydropsychidae pupae	----	----	3(3)	2(2)	----	----
Rhyacophilidae						
Rhyacophila angelita	----	----	13(10)	----	1(2)	7(12)
Rhyacophila vao	----	----	1(2)	----	----	----
Rhyacophila vagrita	----	----	----	----	1(2)	----
Glossosomatidae						
Glossosoma sp.	----	----	497(282)	106(21)	----	----
Hydroptilidae						
Ochrotrichia	----	----	----	3(6)	----	----
Brachycentridae						
Brachycentrus sp.	17(14)	4(3)	146(140)	65(41)	----	----
COLEOPTERA						
Elmidae						
Zaitzevia parvula	----	----	4(7)	----	----	----
Optioservus quadrimaculatus	----	----	1(2)	----	----	----
DIPTERA						
Deuterophlebiidae	----	----	1(2)	----	----	----
Tipulidae						
Hexatoma sp.	2(3)	2(3)	2(3)	2(3)	----	----

AUGUST (Continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=3 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Simuliidae						
Simulium sp.	371(546)	1,796(2,211)	1,329(1,115)	149(99)	13(22)	8(11)
Simulium arcticum pupae	2(3)	91(148)	2(3)	----	----	----
Chironomidae						
Chironomidae larvae	1,118(413)	1,559(1,474)	2,935(1,039)	1,515(479)	7,819(1,973)	6,524(2,233)
Chironomidae pupae	2(3)	----	19(14)	1(2)	48(46)	77(94)
Chironomidae adults	----	----	8(14)	----	7(14)	49(44)
Tanyderidae						
Protanyderus sp.	----	----	1(2)	----	----	----
Athericidae						
Atherix variegata	1(2)	4(6)	12(3)	2(2)	----	----
OTHER INVERTEBRATES						
Turbellaria	2(5)	2(2)	2(3)	3(6)	490(94)	209(105)
Nematoda	3(4)	14(11)	181(303)	226(263)	12(14)	6(12)
Oligochaeta						
Lumbriculidae	----	1(2)	5(5)	34(30)	226(170)	100(65)
Naididae	----	6(12)	257(341)	172(196)	360(348)	84(95)
Hydracarina	27(34)	3(6)	368(255)	377(249)	798(366)	102(53)

SEPTEMBER (9-11-80)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
EPHEMEROPTERA						
Siphlonuridae						
Ameletus cooki	20(22)	2(3)	3(6)	----	----	----
small Siphlonuridae	3(6)	----	6(12)	----	----	----
Baetidae						
Baetis tricaudatus	1,979(753)	540(90)	456(170)	306(219)	26(41)	43(74)
Baetis bicaudatus	----	----	----	----	175(109)	270(211)
Baetis hageni	347(138)	86(53)	19(23)	17(31)	----	----
Pseudocleon sp.	41(38)	4(6)	1(2)	4(8)	----	----
Heptageniidae						
Rhithrogena hageni	986(149)	517(255)	524(127)	668(608)	----	----
Rhithrogena robusta	11(14)	2(2)	23(9)	5(11)	----	1(2)
Epeorus sp.	75(53)	16(10)	6(12)	2(2)	----	----
Epeorus grandis	----	----	----	----	5(5)	2(3)
Epeorus (Iron) sp.	----	1(2)	----	1(2)	1(2)	----
Epeorus longimanus	----	----	----	----	----	1(2)
Cinygmula sp.	674(180)	324(161)	282(146)	212(318)	44(21)	38(16)
Ephemerellidae						
Ephemerella doddsi	144(43)	116(21)	24(21)	38(32)	1(2)	----
Ephemerella inermis	457(126)	129(59)	79(86)	60(45)	----	----
Ephemerella tibialis	3(4)	2(2)	56(43)	8(13)	----	----
Ephemerella flavilinea	----	----	----	1(2)	----	----
Ephemerella spinifera	----	----	----	2(3)	----	----
Leptophlebiidae						
Paraleptophlebia heteronea	47(30)	2(3)	2(2)	3(6)	----	----
PLECOPTERA						
Pteronarcidae						
Pteronarcys californica	----	----	8(5)	2(3)	----	----
Pteronarcella badia	----	1(2)	35(29)	22(25)	----	----

SEPTEMBER (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n-4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Taeniopterygidae						
Taenionema pacificum	781(444)	419(278)	209(148)	261(331)	6(12)	----
Nemouridae						
Zapada cinctipes	24(10)	8(13)	41(29)	12(20)	7(12)	13(23)
Zapada columbiana	----	----	2(3)	----	7(7)	6(8)
Capniidae						
small Capniidae	274(168)	133(65)	137(60)	221(159)	24(34)	27(32)
Peltoperlidae						
Peltoperla brevis	----	----	----	----	1(2)	----
Perlidae						
Classenia sabulosa	6(4)	8(6)	48(37)	15(21)	----	----
Hesperaperla pacifica	37(32)	5(5)	5(2)	4(6)	----	----
small Perlidae	52(32)	15(24)	12(14)	16(23)	----	----
Perlodidae						
Skwala parallela	----	6(12)	----	1(2)	----	----
Isogenoides colubrinus	----	----	1(2)	3(3)	----	----
Diura knowltoni	1(2)	----	----	----	2(2)	7(12)
Isoperla fulva	26(17)	14(9)	48(80)	21(19)	----	----
Isoperla patricia	----	----	2(3)	1(1)	----	----
small Perlodidae	5(7)	----	1(2)	1(1)	----	----
Chloroperlidae						
Sweltsa coloradensis	----	1(2)	7(8)	4(5)	----	----
Suwallia pallidula	4(6)	3(4)	11(11)	2(2)	----	----
Suwallia autumna	2(3)	----	5(9)	----	----	----
Chloroperlid sp. A	1(2)	----	2(3)	35(47)	----	----
small Chloroperlidae	6(12)	6(12)	104(93)	86(104)	----	----
TRICHOPTERA						
Hydropsychidae						
Arctopsyche grandis	18(18)	22(16)	196(66)	54(53)	----	----
Symphitopsyche oslari	197(72)	195(145)	2(2)	1(1)	----	----

SEPTEMBER (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
Hydropsychidae (cont.)						
Symphitopsyche cockerelli	24(7)	54(32)	11(9)	7(10)	----	----
Hydropsyche occidentalis	48(18)	46(28)	4(4)	----	----	----
small Hydropsychidae	121(98)	149(91)	127(143)	185(262)	----	----
Rhyacophilidae						
Rhyacophila angelita pupae	2(2)	----	2(2)	1(1)	----	----
Rhyacophila coloradensis	----	----	----	----	3(2)	2(3)
small Rhyacophila sp.	----	6(12)	----	----	----	----
Glossosomatidae						
Glossosoma sp.	30(22)	1(2)	197(341)	94(152)	----	----
Brachycentridae						
Brachycentrus sp.	9(13)	8(13)	64(120)	10(8)	----	----
DIPTERA						
Tipulidae						
Hexatoma sp.	2(3)	2(3)	2(2)	3(2)	----	----
Ceratopogonidae	----	1(2)	----	----	----	----
Simuliidae						
Simulium sp.	33(19)	75(68)	66(21)	92(112)	19(35)	3(4)
Simulium arcticum pupae	2(3)	2(3)	1(2)	1(1)	----	----
Chironomidae						
Chironomidae larvae	1,929(487)	1,296(560)	1,748(703)	886(793)	4,484(1,737)	4,136(429)
Chironomidae pupae	75(33)	14(16)	64(35)	27(41)	138(33)	127(88)
Chironomidae adults	61(60)	11(11)	8(13)	----	7(5)	2(2)
Tanyderidae						
Protanyderus sp.	----	----	----	----	----	----
Athericidae						
Atherix variegata	1(2)	1(2)	4(4)	4(6)	----	----
Empididae						
Chelifera sp.	----	----	6(12)	----	----	----
Hemerodromia sp.	----	----	----	----	6(12)	----

SEPTEMBER (continued)

	Bible Camp		Kokanee Bend		South Fork	
	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)	Kick n=4 $\bar{x}$(s.d.)	Circular n=4 $\bar{x}$(s.d.)
OTHER INVERTEBRATES						
Turbellaria			4(2)	5(7)	245(224)	169(41)
Nematoda	37(42)	6(12)	27(46)	54(77)	6(12)	30(60)
Oligochaeta						
Lumbriculidae	2(3)	2(5)	26(31)	10(18)	201(117)	290(61)
Naididae		54(93)	50(58)	297(528)	198(229)	72(102)
Hydracarina	180(192)	71(109)	67(95)	126(154)	354(305)	114(135)

South Fork Chemical Analysis
Run by the Fresh Water Research Lab,
University of Montana Biological Station

DESCRIPTION	POC		DOC		Na^+		K^+		NO_3^-		$SO_4^=$		Ca^{++}		Mg^{++}		TSS		TP		Alk.
S. Fork 12/18/79	.103		1.978		.62	.63	.30	.36	.35		1.93	1.96	21.23	21.25	4.9		.2				
S. Fork 1/16/80	.063		1.652		.70	.72	.27		.27	.28	1.77	1.90	21.3	22.23	4.8	5.23	.2	.55			
S. Fork 2/12/80	.08	.06	1.64	1.55	.67		.36		.24	.28	1.94	1.95	22.13		5.27		.35	.3	.013		
S. Fork 3/14/80	.07		1.43		.70		.36		.33	.35	2.14	2.23	22.63		5.44	5.47	.55	.1			76.0
S. Fork 4/14/80	.08	.06	1.48	1.42	.72		.36		.29		2.3		24.7	24.6	5.8	5.9	.3				77.0
S. Fork 5/12/80	.06		2.01		.67		.36		.27		2.2		25.2	25.0	5.9	6.2	.6				
S. Fork 6/8/80	.046		1.97		.71	106%	.31	104%	.28		4.1		22.0	22.8	6.4		.3				
S. Fork 7/14/80	.063		1.4		.64		.36		.25		2.0		22.6	22.7	5.3	5.8	.8		.003		
S. Fork 8/12/80	.11		1.6		.62		.37		.17		2.3		23.7		5.1		1.4		.0019		
S. Fork 9/11/80	.046		1.4		.68		.38		.31		2.1		22.5	22.7	5.4	5.4	.5				
S. Fork 10/15/80	.053		1.25		.69		.37		.28	.28	2.0	2.0	23.8	100%	5.4	100%					
S. Fork 11/8/80	.04		1.26						.34		2.1		23.9		5.1		N/A		.0026	112%	